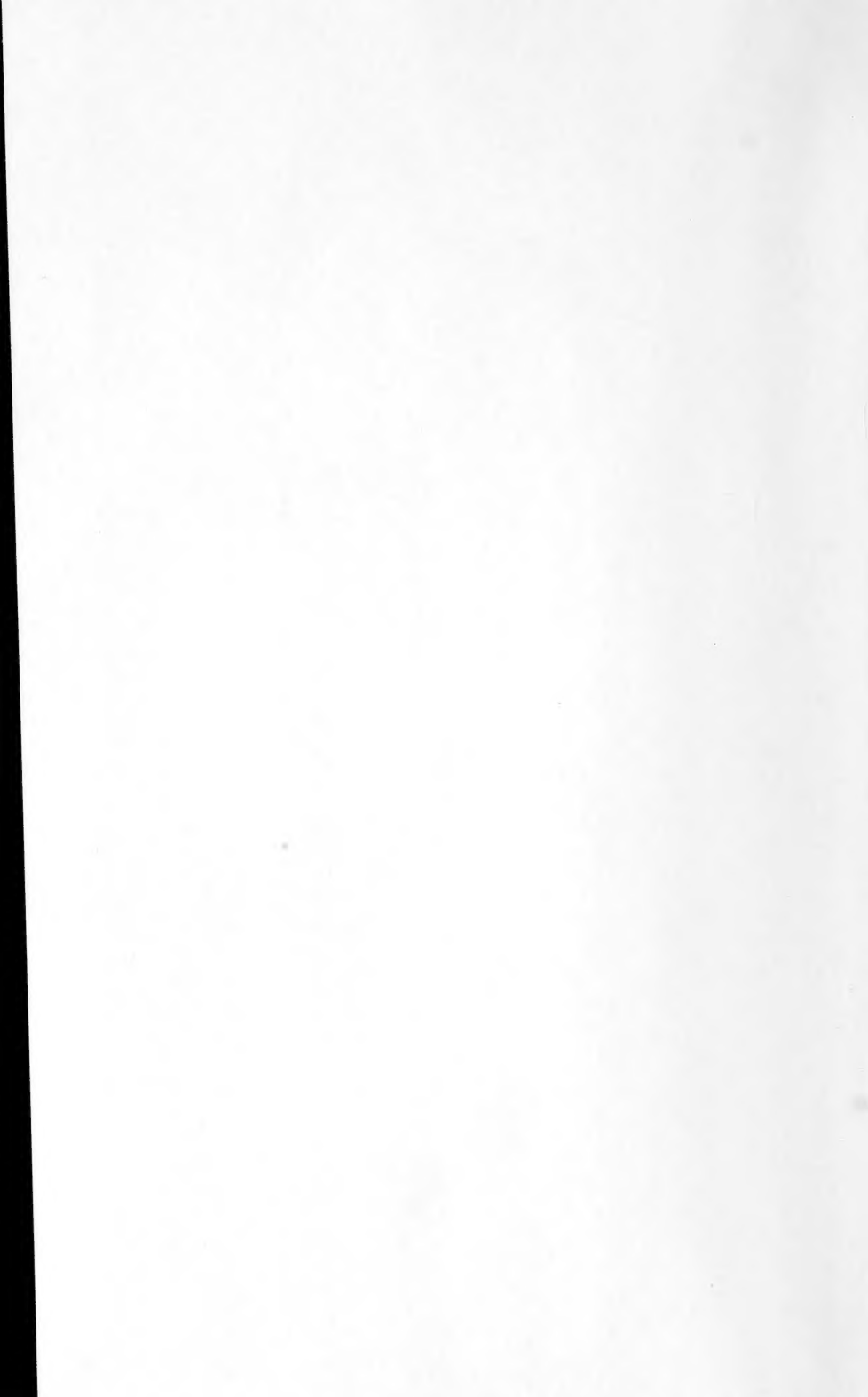


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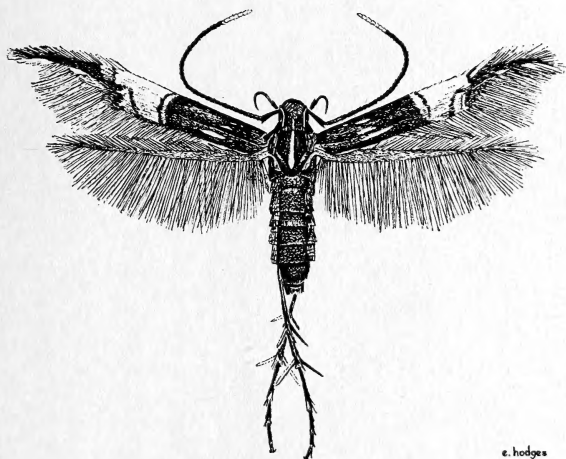
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A SYNONYMIC LIST OF THE NEARCTIC RHOPALOCERA

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Volume 30

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Number 1

PRESIDENTIAL ADDRESS 1975— TO MY FELLOW AMATEURS

ANDRÉ BLANCHARD

P. O. Box 20304, Houston, Texas 77025

The title of Dr. Rindge's Presidential Address to the twelfth annual meeting of the Pacific Coast Section at San Diego, California (1965) was: "The Importance of Collecting—Now". In it he explained that we were—we still are of course—in a losing race against the spread of civilization and concomitant destruction of breeding grounds for Lepidoptera. His address was a plea for immediate and intensive collecting of butterflies and moths. I am sure that few professionals needed such a reminder but I hope that many amateurs listened and followed his advice. Yet, and in full agreement with everything that he said, I would like to add my two cents worth of comments to Dr. Rindge's appeal.

The number of amateurs interested in moths is disproportionately smaller than that of those interested in butterflies, yet there are many times more species of moths than of butterflies. If there are, say, ten times more species of moths and ten times less people interested in them, this is a deficiency factor of one hundred against the moths. In such a situation it is indeed very likely that many, many species of moths will disappear from the earth before they are seen by a single taxonomist. How can we hope to redress such an imbalance? By showing that studying moths can be more rewarding because there is a lot more to be discovered about them.

Before I go any further, let me tell you that I am very much aware of the fact that we do not have enough collectors even of butterflies, that we would like to have several times more of them. Nothing that I am going to say should be interpreted as an attempt to dissuade anybody from collecting butterflies: my ambition is only to convince some amateurs to work on moths in parallel with butterflies and to kindle an interest in moths in some neophytes.

Most of us come to lepidopterology for the pleasure of assembling a beautiful collection. We may differ as to how geographically extensive it will be or as to which groups of Lepidoptera will be included, but I think that nearly all of us start that way. Let me tell you, between parentheses that, from my contacts with many professionals, I have come to the conclusion that most of them are dyed in the wool amateurs who have found a way of getting paid for doing what they would gladly do, at their own expense, if they could afford to do so.

However, many of us amateurs can not be happy for long, with collecting Lepidoptera the way others collect postage stamps. Mere collecting of course is all right and quite satisfying for many, but those who graduate to the studying stage find their hobby considerably more satisfying. The key words are studying, doing research, and as there is immensely more that is unknown and unexplored among the Heterocera, the chances of hitting on something new are considerably better with moths than with butterflies. Where is the amateur who is not thrilled when he discovers something new like a wide extension of range, a new food-plant, a new detail of a life history or a species new to Science? Moths, just because they are not overall as pretty as most butterflies, reserve their rewards for those who study them a little more deeply.

Lepidopterology is a wonderful science in which you do not need to be an expert—as you would have to be in Mathematics, Physics or Biology for instance—to do some simple, simple but useful research.

A good point of moths is that they are rather easy to collect: this is not the place to explain how, but I rather like my method which consists of setting the traps at sunset, going to sleep, and gathering the loot at daybreak. The only disadvantage of this method is that you miss the day flying species and those which come only at bait.

Moths, of course, are divided in Macroheterocera and Microheterocera. Both groups are replete with discoveries waiting to be made, but the micros are even more so.

One of the most promising avenues to discovery is through rearing of larvae: rearing and careful field observations are research at its best, and this type of activity requires only very inexpensive equipment. When you come to think that in some good size genera, the larva or the food-plant of not a single species is known, you realize that by rearing all the larvae that you can procure, you stand a more than even chance of discovering from time to time something well worth your trouble. Good records of everything should of course be maintained, some larvae and pupae preserved by pickling or dehydrating.

There was a time, late in the nineteenth and early in this twentieth centuries when entomologists vied for the description of new species.

Today, it sometimes seems that they need an excuse to do so, unless it is in the course of a group revision. These group revisions, however, which have become their main activity, bring forth amazing results: hardly any genus is revised without recognizing several new species which had been overlooked, or splitting the genus into two or more genera. In any case, these group revisions necessitate bringing together, and making available to the reviser, all the material available in all the museums and the private collections. If you have any material available in the genus being revised, this is your chance of contributing something valuable which will, of course be fully acknowledged.

I have already mentioned that the micros are even less well understood than the macros. This, really is an understatement: some groups of micros are so poorly known that it is almost useless to request identification of specimens: more than half return with at most a genus name. These are orphan groups and you do not have to go very far down the check list of micros to find such groups: the Epipaschiines—a subfamily of the Pyralids—are a good example. I have assiduously collected them, prepared male and female genitalia and discovered that they are too similar to be of much help, on top of that several species look alike and there is some sexual dimorphism. I may be wrong but I am inclined to think that this is, in part at least, why these groups have been left alone and that, in cases like that, the success of a revision and the willingness of a potential reviser to tackle the job depend on the availability of good, long reared series of specimens with preserved larvae, pupae, eggs and careful records of everything including foodplants. Professionals will take care of all this for economically important species, but we, amateurs, could and should do it for all kinds of species. These would be wonderful projects for young amateurs. I say young, because the fruition of their efforts may come only after several years of routine and not immediately rewarding work. But would not the result be worth the effort?

Will my plea bring forth the hoped for response? Not if I merely urge the amateurs to go ahead blindly into a world unfamiliar to most of them. This is where I turn to the professionals and tell them: we want, we need your help! I wonder if one of you "Pros" would come forth, prepare for us and publish in the *Journal* a clear and easy guide to the moths and particularly the micros. I do not mean something as complete and forbidding as Forbes' key in Volume One of his "Lepidoptera of New York and Neighboring States," but a summary of the most easily observed characters of the different families and—where possible—subfamilies, well illustrated with sketches showing palpi, antennae, wing shapes, types of maculation, etc. This, in my opinion, is the most helpful tool that the professional could give the amateur.

I directed my address to "My Fellow Amateurs" because I meant it as a plea to some of them, who may not realize that the study of the moth, less glamorous perhaps than the study of the butterfly, is in the long run more rewarding. But, to the enthusiasm of the amateur, let the professional add the support of his knowledge. Let him give us the guide we need, let him stake out the road to lead us into the strange but wonderful world of the humble moth.

CAPTURE OF A HYBRID *LIMENITIS ARTHEMIS ASTYANAX* \times *L. ARCHIPPUS* (NYMPHALIDAE) IN SOUTHERN GEORGIA

On 22 September 1974 a recently emerged male hybrid between *Limenitis arthemis astyanax* (Fabricius) and *L. archippus* (Cramer) (form *rudidus* Strecker) was captured near Fort Jackson, Savannah, Chatham Co., Georgia. *Limenitis archippus* was abundant in the area, but *L. a. astyanax* was not observed. The specimen (Fig. 1) is presently in the author's collection.

Platt & Greenfield (1971, J. Lepid. Soc. 25: 278-284) reported the capture of a similar interspecific hybrid in North Carolina and listed 12 previously known records of such hybrids. An additional North Carolina specimen was reported by Greenfield & Platt (1974, J. Lepid. Soc. 28: 72-75). The individual captured at Savannah and the two from North Carolina are apparently the only known records of this form from the southeastern U.S.A.

RICHARD T. ARBOGAST, 114 Monica Blvd., Savannah, Georgia 31406.

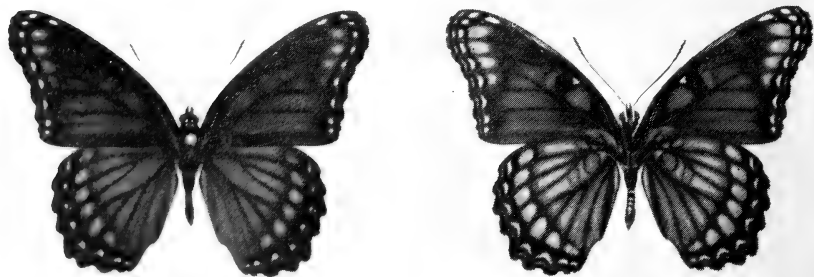


Fig. 1. Male *L. arthemis astyanax* \times *L. archippus* collected near Fort Jackson, Savannah, Georgia, on 22 September 1974 by R. T. Arbogast. Left: dorsal surface; right: ventral surface.

NEW HESPERIIDAE RECORDS FOR TEXAS AND THE
UNITED STATES

WILLIAM W. MCGUIRE

P.O. Box 29884, San Antonio, Texas 78229

AND

MICHAEL A. RICKARD

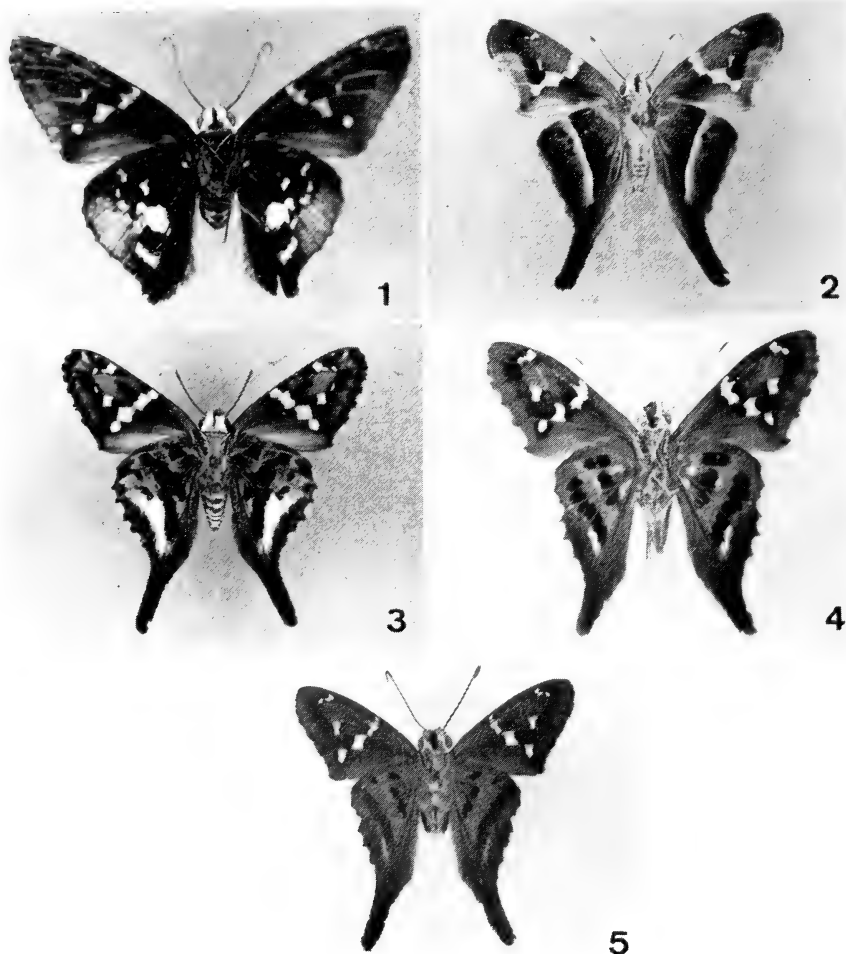
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The Rio Grande Valley of Texas, located in the extreme southern section of the state and encompassing areas of essentially neotropical habitat, offers a unique opportunity for the study of Lepidoptera in the U.S.A. The authors have had the good fortune to collect this area rather frequently during the past several years and during that time some interesting and important new records of HesperIIDae have been obtained.

During 1972-1974 specimens of several rare HesperIIDae, previously known in the U.S.A. from only a few examples, were taken: *Aguna asander* (Hewitson), *Aguna claxon* Evans, *Typhedanus undulatus* (Hewitson), *Polythrix mexicanus* Freeman, *Proteides mercurius* (Fabricius), *Urbanus doryssus* Swainson, *Panoquina fusina evansi* (Freeman), *Asraptres gilberti* Freeman, *Carrhenes canescens* (R. Felder), *Gorgythion begga pyralina* (Moschler) and *Lerema ancillaris liris* Evans. In addition 12 species of HesperIIDae were taken that represent apparent new U.S.A. records, another that is at least a new Texas record, and two others that substantiate previous but little known Texas records. Nomenclature and arrangement follows that of Evans (1952, 1953, 1955) and determinations, unless otherwise indicated, were made by Rickard.

Epargyreus exadeus cruza Evans. Fig. 1. McGuire collected 1 ♀ in McAllen, Hidalgo County on 18 October 1973 as it fed on blossoms of Queen's Crown, *Antigonon leptopus* H. and A. (Polygonaceae). Previous records for this species are confusing: Holland (1931), p. 330, listed *E. exadeus* (Cramer) as "a straggler in southern California, New Mexico and Arizona." However, Evans (1952) stated that what Holland illustrated was *E. exadeus cruza* rather than *exadeus exadeus* (Cramer), and noted other distribution for *cruza* as Mexico, Guatemala, Nicaragua, Salvador, Costa Rica, and Panama (transitional to *exadeus exadeus*). This is the first known record of this skipper for Texas.

Aguna metophis (Latreille). Fig. 2. Rickard took a worn ♀ in Bentsen-Rio Grande Valley State Park, Hidalgo County, 6 September 1969, det. H. A. Freeman. Other Texas records include Mission, Hidalgo County, 10 September 1972, 1 ♀ (Roy O. Kendall); Santa Ana National Wildlife Refuge, Hidalgo County, 10 and 27 October 1973, 1 ♂ each date (Rickard); Loop 374 west of Mission, Hidalgo County, 18 October 1973, 1 ♂, and 19 October 1973, 1 ♀ (McGuire) and 26



Figs. 1-5. 1, *Epargyreus exadeus cruzi* Evans, ♀, ventral, McAllen, Texas, 18 October 1973; F 28 mm. 2, *Aguna metophis* (Latreille), ♀, ventral, Loop 374, Mission, Texas, 19 October 1973; F 23 mm, tail 10 mm. 3, *Codatractus alcaeus alcaeus* (Godman & Salvin), ♀, ventral, McAllen, 19 October 1973; F 26 mm. 4, *Urbanus prouti* Evans, ♂, ventral, Ciudad Victoria, Tamaulipas, Mexico, 24 December 1973; F 23 mm, tail 5 mm. 5, *Urbanus esmeraldus* Butler, ♂, ventral, McAllen, 18 August 1972; F 20 mm, tail 10 mm.

October 1973, 1 ♂ (Rickard); Galveston, Galveston County, 7 August 1973, a worn ♀ (McGuire). Distribution noted by Evans (1952) includes Mexico, Nicaragua, Panama, Venezuela, Matto Grosso and South Brazil.

Codatractus alcaeus alcaeus (Godman & Salvin). Fig. 3. The first record for this species in Texas was given by Freeman (1951) as a single specimen from the Davis Mountains, no data. A single worn specimen was collected and reported



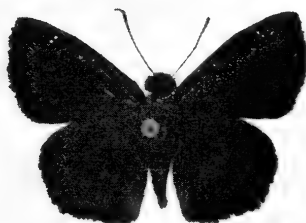
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Figs. 6–10. *Astraptes egregius egregius* Butler, ♀, dorsal, Bentsen-Rio Grande Valley State Park, Texas, 18 October 1973; F 24 mm. 7, *Astraptes alardus latia* Evans, ♂, ventral, San Fernando, Tamaulipas, Mexico, 23 October 1973; F 28 mm. 8, *Achalarus jalapus* (Plötz), ♂, ventral, Sullivan City, Texas, 31 July 1972; F 25 mm. 9, *Bolla clytius* (Godman & Salvin), ♂, dorsal, Abrams, Texas, 18 October 1973; F 15 mm. 10, *Sostrata bifasciata nordica* Evans, ♂, dorsal, Bentsen-Rio Grande State Park, 26 October 1973; F 15 mm.

by J. Richard Heitzman (1970) from Boca Chica, Cameron County, 27 June 1968. On 19 October 1973 McGuire collected 1 ♂ at Penitas and 1 ♀ at McAllen, both Hidalgo County. Obviously uncommon in Texas, it is at times abundant at Ciudad Valles, San Luis Potosi, Mexico (H. A. Freeman, pers. comm.) which is about 500

mi south of the Texas border and was recorded by Evans (1952) from Honduras, Nicaragua and Costa Rica, as well as Mexico.

Urbanus prouti Evans. Fig. 4. Rickard took a ♀ along a railroad track near Madero, Hidalgo County on 19 October 1969. It was visiting blossoms of *Lantana horrida* H. B. K. It was papered as *U. proteus* (Linnaeus) and the true identity not discovered by the author until September 1973. Previous distribution records are from throughout Mexico and Central America south to Paraguay (Evans, 1952).

Urbanus esmeraldus Butler. Fig. 5. A single specimen of this species was found by McGuire among his *Urbanus* material following Rickard's discovery of *U. prouti*. The specimen is a fresh ♂, collected 18 August 1972 at McAllen. This species is rather widespread from Mexico south to Paraguay (Evans, 1952) and at times rather common in southern Tamaulipas, Mexico, within 350 mi of the Texas border.

Astraptus egregius egregius Butler. Fig. 6. A ♀ was taken by McGuire, 18 October 1973 in Bentsen State Park. The usual habitat of this species is central Mexico south to the Amazons (Evans, 1952) and this record, as confirmed by Mr. H. A. Freeman, represents a significant range extension as well as a new United States record.

Astraptus alardus latia Evans. Fig. 7. Rickard took three specimens in 1973: Bentsen State Park, 16 June (1 worn ♀) and 10 October (1 fair ♀), and Santa Ana Refuge, 1 September (1 fresh ♂). All were collected in wooded areas as they rested under large leaves. This distinctive *Astraptus* has been recorded from Central America and Colombia by Evans (1952), and found rarely by McGuire in Tamaulipas, Mexico, within 200 mi of Texas.

Achalarus jalapus (Plötz). Fig. 8. A fresh ♂ was taken by McGuire, 31 July 1972 near Sullivan City in western Hidalgo County. Roy O. Kendall collected (and det.) 1 ♀ on 8 September 1972 and 1 ♂ on 9 September 1972 in Mission, Hidalgo County. In 1973, Rickard took 2 ♂♂ at McAllen, 23 September and 20 October, and John B. Vernon collected 1 ♀ at the same location on the latter date. This species has probably been often confused with the more common *A. toxus* (Plötz), from which it can be distinguished by the presence of the lobed hindwing in *jalapus*. Recorded by Evans (1952) from Mexico (Jalapa; Granahl; Guadalupe), Guatemala, Honduras and Columbia, it is not uncommon 300 mi south of Texas (McGuire).

Bolla clyti (Godman & Salvin). Fig. 9. On 18 October 1973 McGuire collected 2 ♂♂ and 1 ♀ southwest of Mission near the village of Abrams, Hidalgo County; these were all taken along a wooded canal as they visited *Aster* blossoms. Determination of these specimens prompted the authors to contact Mr. J. W. Tilden, who had previously reported *Bolla brennus* from the Rio Grande Valley (Tilden, 1971) and ask that he recheck his *Bolla* specimens. This was done and Tilden confirmed his earlier determination of *B. brennus*, thus establishing the presence of two species of *Bolla* in Texas and the U.S.A. Evans (1953) records this species from only Mexico and Honduras.

Sostrata bifasciata nordica Evans. Fig. 10. Rickard took 2 ♂♂ in Bentsen-Rio Grande Valley State Park on 26 October 1973. They were patrolling small patches of light in a wooded area late in the afternoon. This species has also been found rather commonly by McGuire in the Ciudad Victoria area of Mexico, and is recorded from Mexico, Guatemala, Honduras, Nicaragua, and Costa Rica by Evans (1953).

Heliopterus arsalte arsalte (Linnaeus). Fig. 11. McGuire collected a pair of fresh specimens at Boca Chica, east of Brownsville, Cameron County, late in the evening of 20 October 1973; both were flying about in open chaparral in company with *Heliopterus laviana* (Hewitson) and *H. macaira* (Reakirt). McGuire had previously collected this species within 200 mi of the Texas border, near Ciudad Victoria; Evans (1953) lists distribution throughout Mexico, Central and South America, and Trinidad.



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Figs. 11-15. 11, *Heliopetes arsalte arsalte* (Linnaeus), ♀, ventral, Boca Chica, Texas, 20 October 1973; F 16 mm. 12, *Piruna microsticta* (Godman), ♀, ventral, Sullivan City, 20 October 1973; F 10 mm. 13, *Corticea corticea corticea* (Plötz), ♂, dorsal, Bentsen-Rio Grande Valley State Park, 3 September 1972; F 12 mm. 14, *Rhinthon osca* (Plötz), ♀, dorsal, Loop 374, Mission, 20 October 1973; F 21 mm. 15, *Conga chydaea* (Butler), ♂, dorsal, Bentsen-Rio Grande Valley State Park, 15 July 1972; F 14 mm.

Piruna microsticta (Godman). Fig. 12. Evans (1955) recorded 1 ♂ from Texas as well as specimens from Mexico. Holland (1931), p. 361 noted the species as occurring in northern Mexico and "reported as having been taken in Arizona near the Mexican border." After finding specimens in arid terrain in southern Tamaulipas, Mexico, a search of similar habitat near Sullivan City, Hidalgo County, led to McGuire's capture of 1 ♀ on 20 October 1973, which reinforces Evans' earlier record for Texas.

Corticea corticea corticea (Plötz). Fig. 13. We have taken a number of examples of this rather common Mexican species to date. Rickard collected 1 ♂ at Madero on 4 November 1973 and 2 ♀♀ in Bentsen-Rio Grande Valley State Park. 16 December 1973. A subsequent search of the authors' collections turned up additional records: Bentsen State Park, 3 September 1972, McGuire (1 ♂) and Santa

Ana National Wildlife Refuge, 9 November 1968, Rickard (1 ♂, 1 ♀). These specimens had been mislabeled *Nastra julia* (Freeman). The obscure appearance and superficial resemblance to *N. julia* has doubtless caused other collectors to overlook or mislabel *corticea*. The species is widely distributed throughout Mexico, Central America and South America as far south as Argentina (Evans, 1955).

Rhinthon osca (Plötz). Fig. 14. Rickard captured a fresh ♀ in a wooded area along Loop 374 west of Mission, Hidalgo County, on 20 October 1973; he collected a second ♀ in good condition south of Mission near the village of Madera, Hidalgo County, 26 October 1973 as it visited blossoms of *Eupatorium odoratum* L. Previously, *R. osca* has been considered a subspecies of the Antillean *R. cubana* Herrich-Schaffer), but the authors are advised by H. A. Freeman (pers. comm.) that it should be accorded specific status. McGuire has previously collected specimens as far north as Ciudad Mante, Tamaulipas, Mexico, and Evans (1955) notes distribution from Mexico south to Ecuador.

Conga chydæa (Butler). Fig. 15. McGuire collected specimens in Bentsen-Rio Grande Valley State Park on 15 July 1972 (1 ♂, 1 ♀) and 2 September 1972 (1 ♂); Rickard collected 2 ♀♀ on 25 October 1973 as they visited blossoms of Queen's Crown along a canal in McAllen. This species is relatively common in Mexico to the south of Ciudad Mante, and noted by Evans (1955) to be recorded as far south as Argentina.

ACKNOWLEDGMENTS

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HAPALIA NIGRISTRIATALIS A SYNONYM OF UDEA ANGUSTALIS
(PYRALIDAE: PYRAUSTINAE)

In my recent paper on the *Udea angustalis* group (Munroe, 1974, Can. Ent. 106: 139-142), I did not consider *Hapalia nigristriatalis* Hampson (1918, Ann. Mag. Nat. Hist. 9(2): 395), described from a single male from San Antonio, Colombia, collected by Palmer. Examination of a photograph of the holotype, made by me at the British Museum (Natural History) in 1958 (Fig. 1), shows that *H. nigristriatalis* should be transferred to *Udea* Guenée, 1844, where it becomes *Udea nigristriatalis* (Hampson), new combination, and falls as a synonym of *Udea angustalis* (Dognin, 1905), already known to range from southern Mexico to Bolivia.

EUGENE MUNROE. Biosystematics Research Institute, Agriculture Canada, Ottawa, Ontario, Canada.

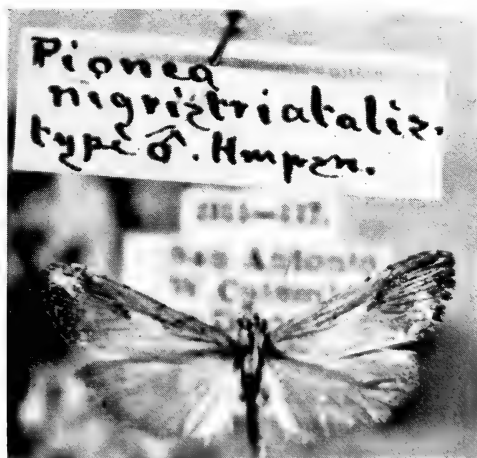


Fig. 1. *Hapalia nigristriatalis* Hampson, 1918, holotype, male, San Antonio, West Colombia, Palmer, British Museum (Natural History). Black and white print from Kodachrome transparency. Wingspan of specimen 22 mm. The type-label was made by Hampson before he began to use the name *Hapalia* Hübner for the collective genus he had for many years called *Pioneer* Guenée.

A NEW SUBSPECIES OF *ARGYREUS HYPERBIUS* (*NYMPHALIDAE*) FROM NEW GUINEA

CHRIS SAMSON

Saruman, St. Giles in the Wood, Beckley, E. Sussex, England

***Argyreus hyperbius niugini* Samson, subsp. nov.**

Male. Forewing length: 37–45 mm.

Dorsal surface: Margins well defined, particularly those of the hindwings which, when combined with broad submarginals, produce a wide band. In addition to black bar of hindwing discal cell, there are remnants of another on discocellulars.

Ventral surface: Constant character appears to be the absence of silver spot which, in nominate subspecies and majority of others, is present in dark postbasal area of hindwing cell. Absence of such spot also characterised in the Australian subspecies: *inconstans* Butler.

Female. Forewing length: 35–48 mm.

Dorsal surface: Extensive charcoal-blue band, bisecting forewing; black bars in cell are pronounced. White bar in space 4, plus spot therein usually inferior. Hindwing submarginal bands broad, moreso than those of male.

Ventral surface: Markings well defined on fore- and hindwings; broad hindwing submarginals. As in male, silver spot absent in dark area of hindwing cell.

Holotype. Male: New Guinea, Nondugl (Central Highlands), 5,500 ft., October 16, 1950. Coll. by Wm. Brandt (E. J. L. Hallstrom). Forewing length, 43 mm.

Allotype. Female: same as holotype, but November 1950. Forewing length, 45 mm.

The above primary types are in the Australian National Insect Collection, Canberra, A. C. T.

Paratypes. 6 ♂♂, 5 ♀♀, Daulo Pass, Eastern Highlands District, New Guinea, 8,000 ft., August 1971 (2 ♂♂, 3 ♀♀ to British Museum [Natural History]; 2 ♂♂ to American Museum of Natural History; 2 ♂♂, 2 ♀♀ retained by author). Also in the British Museum (Natural History): 1 ♀, Br. New Guinea, Foothills between Kikori R. & Purari R. (J. P. de Verteuil); 3 ♂♂, Watut R. to Buiang, west-side of Herzog Mts., 3,200–5,400 ft., early 1928 (A. F. Eichhorn); 4 ♂♂, Saiko, Bubu R., Upp. Waria R. Sept., Beg. October, 5,500 ft., 1936; 2 ♂♂, 2 ♀♀, Zageheme, Cromwell Mts., East Finisterre Range, 20 VI to 7 VII.31, 4800' (F. Shaw Meyer); 1 ♂, same as above, but 16 VII.31. Retained by author: 1 ♂, 1 ♀, New Guinea, Western Highlands, Kandep, 8,000–8,500 ft., 23.1.61 to 14.2.62, W. W. Brandt.

Further material of this subspecies collected by Wm. Brandt in New Guinea, now in the Australian National Insect Collection: 5 ♂♂, 2 ♀♀, Western Highlands, Kandep, 8,000–8,500 ft., 23.1.61 to 14.2.62; 6 ♂♂, 1 ♀, Kodama Range, Mt. Kaindi, 6,500 ft., 24.2.1952, Sir Edward Hallstrom; 8 ♂♂, 4 ♀♀, Nondugl (Central Highlands), 5,500 ft., 1950, Sir Edward Hallstrom (dates range from Sept. 24 to Dec. 12); 3 ♂♂, Western Highlands, Mt. Hagen Valley, Keltiga, 5,600 ft., 28.9 to 25.10.1961; 1 ♀, Western Highlands, Jimi River, 4,700 ft., 16.7 to 21.9.1961; 1 ♂, Telefomin (Eliptamin), 4,500–5,500 ft., 19 June to 14 Sept. 1958.

The Rijksmuseum at Leiden, Netherlands, possess at least 2 males of *A. hyperbius niugini* from Irian Jaya (formerly Dutch New Guinea and

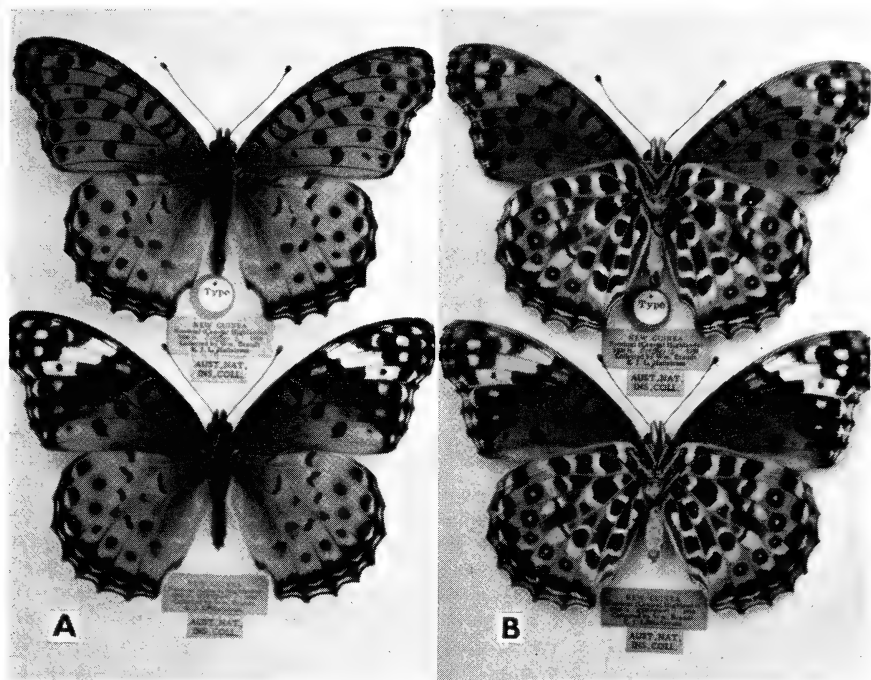


Fig. 1. *Argyreus hyperbius niugini*. A, holotype (male) and allotype (female); B, ventral surfaces of same.

West Irian), i.e., Paniai, 14 & 15.XI.1939. This locality is now known as Enaratoli and lies to the east of Wissel Lakes, at approximately 5700'. In the British Museum (Natural History) there is a female *A. hyperbius* subspecies labelled: Dutch N. Guinea, Kobotil, O. Kaba (BM 1922-165). This appears to be within the known variation of *A. hyperbius javanica* Oberthür, and is a dark, well marked example. I am unable to locate any examples from the Moluccas or intermediate islands, but *A. hyperbius* subspecies reappear in the west in the Sunda Islands, Java and Sumatra, Sulawesi (formerly Celebes) and through India to Abyssinia.

I have seen males and females of *A. h. niugini* from the Central and Northern Districts of Papua, and according to Ray Straatman (pers. comm., 1973): "... the species flies in open areas (grassland) at altitudes from 1500 to 3000 metres and is most common at about 2000 to 3000 metres." D'Abrera (1971, p. 210) records the Australian subspecies, *A. h. inconstans* as occurring also in New Guinea and possibly Papua. All specimens that I have observed from Papua New Guinea are quite

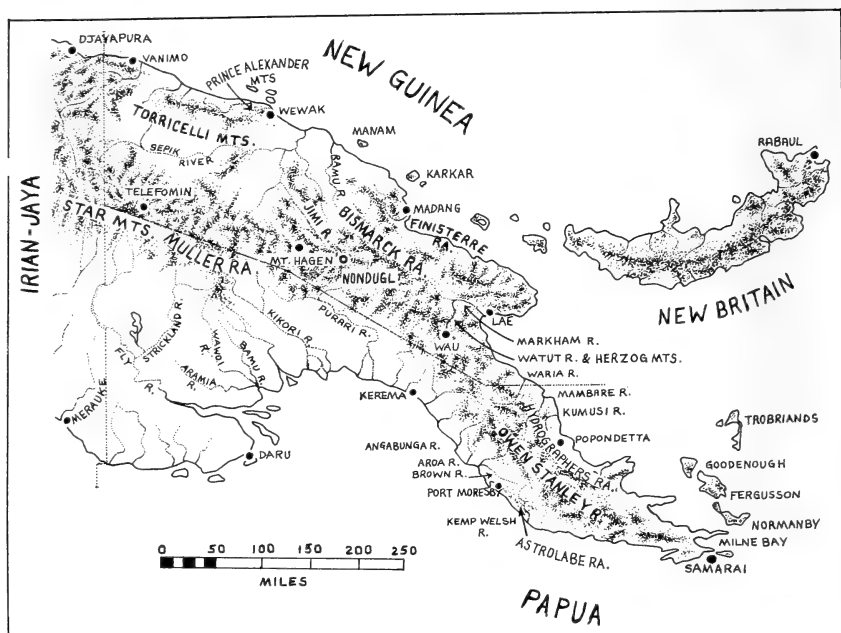


Fig. 2. Map of Papua New Guinea (excluding Manus, New Ireland, Woodlark and Bougainville) indicating main ranges and localities for paratypes and primary type material.

separable from those in Australia which, to the best of my knowledge, are restricted to that area. Thus, we record the new subspecies from mainland Papua New Guinea and Irian Jaya.

The life-history of *A. h. niugini* is probably similar to that of the nominate subspecies from North India, the larvae feeding on Violaceae; indeed, the early stages of *A. hyperbius* from Japan are well illustrated and documented in Shirôzu & Hara (1960, p. 31).

As noted from the material examined, many specimens of *A. h. niugini* were collected by William Brandt, including the primary types; thus, I think it only fitting to include some notes on this accomplished naturalist:

William Brandt came to Australia from Sweden about 1949 and was employed by the late Sir Edward Hallstrom to collect butterflies for him in New Guinea. For five years Brandt built up an impressive collection of Lepidoptera, primarily from Papua and New Guinea, and mainly of the larger species. In 1955 Hallstrom lost interest in his collection of butterflies and donated it to the Australian Government, whereupon it became part of the Division of Entomology, C.S.I.R.O. at Canberra. From 1955 until his retirement about 1969, Brandt continued to collect

mainly Lepidoptera in New Guinea, New Britain, New Ireland, New Hebrides, Solomons and many of the smaller New Guinea islands. In this work he was financed largely by the Bishop Museum, Hawaii; during the latter period the Lepidoptera continued to come to the Australian National Insect Collection, while the other insects went to the Bishop Museum.

Brandt collected for a total of about 15 years in New Guinea, the last three or four years before his retirement being spent working on the Collection in Australia or, for about two years, working on New Guinea Lepidoptera at the British Museum (Natural History). During the period when Brandt was collecting for Hallstrom, the latter insisted that the data labels bore his name, as well as the actual collector. Hallstrom was very interested in New Guinea and set up an Experimental Livestock Station at Nondugl, the type locality for the new subspecies herein described.

ACKNOWLEDGMENTS

I am grateful for the help afforded me by Paul E. Smart (Saruman Museum) and T. G. Howarth (British Museum), both of whom allowed me access to useful material and much valued advice; also to Dr. R. de Jong (Rijksmuseum, Nederlands) and H. J. Balcliffe (Royal Geographical Society, England). Special thanks are extended to Dr. Ian F. B. Common (C.S.I.R.O., Canberra, Australia) for supplying much useful data, plus specimen material for primary and paratypic designation.

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CALLOPHRYS ERYPHON (LYCAENIDAE) IN MAINE

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On the basis of several specimens of a large, boldly marked *Callophrys* recently examined and determined by Mr. J. D. Lafontaine and Mr. Harry K. Clench, *Callophrys* (*Incisalia*) *eryphon* (Boisduval) is here reported to be established in a small acid bog located in western Maine.

Clench (*in* Ehrlich & Ehrlich, 1961) summarizes the eastern range of *C. eryphon* as "eastward to Rockies, Nebraska and northern Manitoba." Klots (1951) does not include *C. eryphon* as occurring east of the Great Plains, nor is it mentioned in his list of casual species. In the past decade however, the species has been discovered to occur much farther east. Recent eastward records include Port Hope, Ontario (Riotte, 1967); Pine Co. (Masters, 1972) and Cook Co. (Huber, 1966), Minnesota; and Chippewa and Luce counties, eastern upper peninsula of Michigan (Nielsen, 1966). The recent Maine checklist (Brower, 1974) contains no mention of *C. eryphon*.

The bog, Black Spruce—sphagnum heath, is roughly 3–5 acres in extent, and is located adjacent to state Rt. 16, east of the Maine–New Hampshire border, approximately 6 mi. S of Wilsons Mills, near the confluence of the Diamond and Magalloway rivers. The area is approximately 1,260 ft. in elevation and surrounded by low mountains. The bog supports a rather dense growth of Black Spruce (*Picea mariana*), Tamarack (*Larix laricina*) and other typical associate plants, e.g., Labrador Tea (*Ledum groenlandicum*), Rhodora (*Rhododendron canadense*), laurel (*Kalmia* sp.), Bog Rosemary (*Andromeda glaucophylla*), various other heaths, grasses and sedges. From early to mid-June *Oeneis jutta* Hübner occurs here, along with an unusually productive colony of *Callophrys augustinus augustinus* (Westwood), and the proliferation of flowering plants attract a variety of other Canadian Zone butterflies in the late spring. Ease of access has made the area a popular collecting spot with numerous New England entomologists.

During two trips to the bog on 8 and 9 June 1974, a good series of *C. eryphon* was taken, both sexes being fairly common. A number of these were later positively identified by Mr. Lafontaine and Mr. Clench. A small series of the same catch was also deposited in the Dartmouth College Museum Collection.

The presence of *Callophrys eryphon* this far east raises a number of

questions concerning (1) sympatry with *C. niphon clarki* Freeman, (2) significance of the bog environment and (3) larval food plant.

I recently re-examined the series of *C. eryphon* now in the Dartmouth College Collection to check the possible inclusion of *C. niphon*. All specimens in the series (7 males, 4 females in fresh to slightly worn condition) appear to be *eryphon*, suggesting that at least within the bog confines, *niphon* does not occur. Locally, however, *C. niphon* is generally common, usually in association with pine woods and occasionally exhibiting local outbreaks (Grey, 1967).

The observed association of this *C. eryphon* colony with a bog needs further clarification. It may be merely apparent, being presently known only from this one locality, and may display other habitat preferences if and when other colonies are uncovered. It should be noted that the Bog Elfin, *C. lanoraieensis* Sheppard, well known from large bogs of north central Maine, does not occur here.

Various endemic pines are listed as food plants for *C. eryphon* in the western montane regions. Other pines are recorded in the east for *C. niphon*: Klots (1951) suggests "probably only 'hard' pines, i.e. *virginiana*, *rigida*, etc., not White Pine (*P. strobus*)", although Ferguson (1954) does not rule out the possibility of this latter species. The common native pines appear to be almost wholly lacking at the Wilsons Mills locale, therefore, it appears possible that something entirely different, perhaps one of the spruces could serve as the host. Nearly all of the *C. eryphon* collected were taken on or near young Black Spruce, the butterflies often alighting on the fresh terminal growth. McGugan (1958) includes White Spruce (*Picea glauca*) as a larval collection source for *C. niphon clarki*, suggesting spruce as an alternate choice for both butterflies. Clearly, however, the matter will remain in question until further observations and life history work can be conducted.

The discovery of *Callophrys eryphon* in the east will doubtless generate continued intensive searches for additional colonies of this "western" butterfly. Collectors having specimens of northern New England *niphon* should check their material carefully and forward any suspect examples along with data to Mr. Clench for determination.

ACKNOWLEDGMENTS

Sincere thanks are extended to Mr. J. Donald Lafontaine, Biosystematics Research Institute, Ottawa, and to Mr. Harry K. Clench, Carnegie Museum of Natural History, Pittsburgh, for species determination, and, especially to the latter, for helpful comments and suggestions and criticism of the manuscript. Thanks are also due Mr. Paul S. Miliotis,

Dunstable, Mass., for originally raising the question of the true identity of the Maine specimens and for checking the botanical names; to Mr. Donald J. Lennox, Jefferson, N. H., for initial introduction to the bog and helpful discussions relating to host plant possibilities; and to Mr. Richard E. Gray, Dartmouth College Museum, Hanover, N. H., for permitting me to examine material in the collection of that institution.

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MATHILDANA NEWMANELLA (OECOPHORIDAE) IN ARKANSAS

Through the courtesy of H. N. Greenbaum (Department of Entomology, University of Arkansas), I recently have been able to examine moths collected with a Malaise trap set up 24 hours a day in Fayetteville, Washington Co., Arkansas. Among the moths collected 22–26 May 1975 were two females of *Mathildana newmanella* (Clemens). Hodges in his recent revision of the North American Oecophoridae (1974, Moths Amer. North of Mex., Fasc. 6.2: 122), reported this moth, originally described from Virginia, as occurring from Quebec to North Carolina and extending west only to southern Ohio. The new record from western Arkansas considerably extends the known range of *M. newmanella*, and, with the range of the deciduous forests ending only a little farther west, this may be near the western limits of its distribution. *M. newmanella* may be a diurnal flier, as are related species such as *Esperia sulphurella* (Fabricius).

JOHN B. HEPPNER, *Department of Entomology and Nematology, University of Florida, Gainesville, Florida 32611.* (Florida Agricultural Experiment Station Journal Series No. 5954.)

NOTES OF MARYLAND LEPIDOPTERA. 5.
A NEW SUBSPECIES OF *POANES MASSASOIT* (HESPERIIDAE)

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AND

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On 19 June 1962, one of us (WAA) captured two unusual specimens of *Poanes massasoit* Scudder in New Bridge, Dorchester County, Maryland. Upon seeing these specimens and learning of their origin, Simmons suggested that they might be representatives of a new subspecies, and further collecting trips were planned. On 12 July 1962, 28 additional specimens were collected from the same locality, and all were noted to differ considerably from both *P. m. massasoit* Scudder and *P. m. hughi* Clark, the previously described northeastern subspecies.

Our collections contain many examples of *P. m. hughi* Clark from northcentral Maryland including its type locality. Morphological comparisons of our eastern shore specimens with those of *P. m. hughi* and *P. m. massasoit* indicate that important taxonomic differences exist between the three entities. A distributional study reveals that our new specimens (Figs. 1-10) represent the most southeastern end of a cline, in which *P. m. massasoit* is the most northerly taxon, with *hughi* representing an intergrade between our new subspecies and *P. m. massasoit*.

The apparent differences noted as one studies the cline from north to south are that the specimens become somewhat larger and there is a progressive loss of areas of yellow scales, especially on the underside of the hindwing of both sexes and on the upper surface of the wings of the female. In this study we will make comparisons with *P. m. hughi* alone as Clark (1932) has already very adequately compared *P. m. massasoit* and *P. m. hughi*.

We name this new subspecies after our late, good friend Franklyn H. Chermock, who plied us with specimens, good humor and many interesting stories about collecting and collectors.

***Poanes massasoit chermocki* Andersen and Simmons new subspecies**

Figs. 1-4, 9-10

Holotype. Male: Forewing length 14.7 mm. Upper surface, forewing: plain, unmarked, color dark, blackish brown with faint mahogany iridescence.

Upper surface, hindwing: same as forewing.

Under surface, forewing: dark brown generally with slightly lighter brown scales at apical area and just inside costal and outer margins. Three small, subapical, yellow-brown spots at costal margin in spaces between veins R-3 and R-4, R-4 and R-5, and R-5 and M-1.

Under surface, hindwing: tan at outer margins, brown centrally. Five yellow, submarginal spots arranged in a rough semicircle paralleling outer margin. A small yellow spot also in discal cell. Between this spot and two of the submarginal spots is a well-defined area of tan scales.

Allotype. Female: Forewing length 16.0 mm. Upper surface, forewing: ground color is the same as in male. Three subapical yellow spots extending in a line inward from costal margin. In postmedian area between veins M-2 and M-3, and and M-3 and Cu-1 are two larger yellow spots, the lower one squarish.

Upper surface, hindwing: same as in male. In rare specimen, only a faint suggestion of one yellow spot in postmedian area.

Under surface, forewing: as in male except with addition of two postmedian spots corresponding to those of upper surface.

Under surface, hindwing: same as in male.

Type localities. Holotype: New Bridge, Dorchester County, Maryland, June 19, 1962. Allotype: same locality, July 6, 1963.

The types are deposited in the U. S. National Museum, Washington, D.C. Male and female paratypes will be deposited in the American Museum of Natural History, New York and in the Carnegie Museum, Pittsburgh, Pennsylvania.

Differences between *P. m. chermocki* and *P. m. hughii*

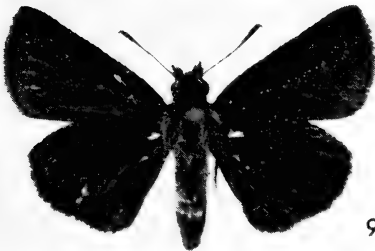
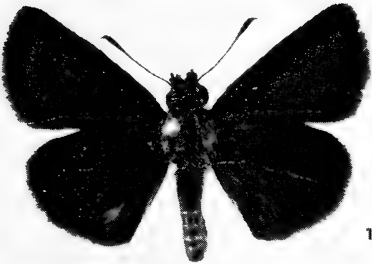
1. The most striking difference is in the under surface of the hindwing where the extensive yellow marking (extending from the discal cell outward to include the submarginal yellow band) of *hughii* is reduced to the narrow yellow submarginal, roughly semi-circular band of individual spots of *chermocki*.
2. The maculation of the *chermocki* female is much reduced on the upper surfaces, so that in half the specimens the forewing is immaculate on the upper surface.
3. The size of *chermocki* is somewhat larger, averaging about 0.5 mm larger per forewing.

DISCUSSION

The locality of New Bridge, Dorchester County, is in the southernmost section of the eastern shore of the Chesapeake Bay, 80 miles due south of the nearest known colony of *P. m. hughii* in Cecil County. Cecil County is the northernmost county on the eastern shore of Maryland. It is divided between coastal plain in its southern portion and piedmont in its northern. The specimens of *P. m. hughii* from Cecil County were

→

Figs. 1-10. *Poanes massasoit* subspecies from Maryland. Left side dorsal surfaces; right, ventral surfaces. 1-4, *P. m. chermocki* (subsp. nov.), New Bridge, Dorchester County: (1 & 2) holotype, male, 19 June 1962; (3 & 4) allotype, female, 6 July 1963. 5-8, *P. m. hughii*: (5 & 6) male, Towson, Baltimore County, 3 July 1954; (7 & 8) female, Beltsville, Prince Georges County, 20 July 1967. 9-10, *P. m. chermocki*, form "suffusa", New Bridge, Dorchester County, 6 July 1963.



1 cm

collected in the piedmont area. Much collecting on Maryland's eastern shore coastal plain between the two areas has not produced any closer colonies. This deme in Dorchester County is thus geographically somewhat isolated from the nearest population of *P. m. hughi* and at the present time this population represents the only one known to us from this region.

The specimens of *P. m. chermocki* are rather homogeneous in their maculation and size as compared with *P. m. hughi* populations. The under surface of the hindwings of specimens of *chermocki* are strikingly similar and there is only slight variation in the spots of the upper surfaces in the female. In our *hughi* specimens, on the other hand, the upper surfaces of the female vary from being spotted on both wings to some having none on either wing, this being in agreement with Clark's description of his subspecies. The underside of the hind wing is similarly varied. Clark (1932) himself described one specimen from Beltsville, Maryland, which is very like *chermocki* and he pictured another such specimen in the frontispiece of his *Butterflies of Virginia* (Clark & Clark, 1951). We note that in our collections of *hughi* from north central Maryland forms similar to *chermocki* occur at a rate of approximately 4 per cent. The form "suffusa" also occurs in this new subspecies. In our series its incidence is about the same as in *hughi*, i.e., 1 in 10.

ACKNOWLEDGMENTS

The authors are greatly indebted to Dr. Austin P. Platt of the University of Maryland, Baltimore County, who not only photographed the specimens and helped make up the plate but also read the manuscript and made helpful criticisms and suggestions. We also thank William F. Andersen who developed and printed the photographs.

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NOTES ON THE LIFE CYCLE AND NATURAL HISTORY OF
BUTTERFLIES OF EL SALVADOR. VII. *ARCHAEOPREPONA*
DEMOPHON CENTRALIS (NYMPHALIDAE)

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During August 1971, one of my sons found a strange-looking larva on a very small unknown shrub in a ravine near the city of San Salvador. The larva unfortunately died before pupating due to the lack of food. We could not identify the shrub because it was not in flower, and our efforts to substitute other similar plants for food were unsuccessful. Two years later, we found a female *Archaeoprepone demophon centralis* Fruhstorfer (Charaxinae) ovipositing on a larger flowering shrub and were able to rear the species to adult. The larvae were the same as the single specimen collected in 1971. Since that time we have reared the species several times.

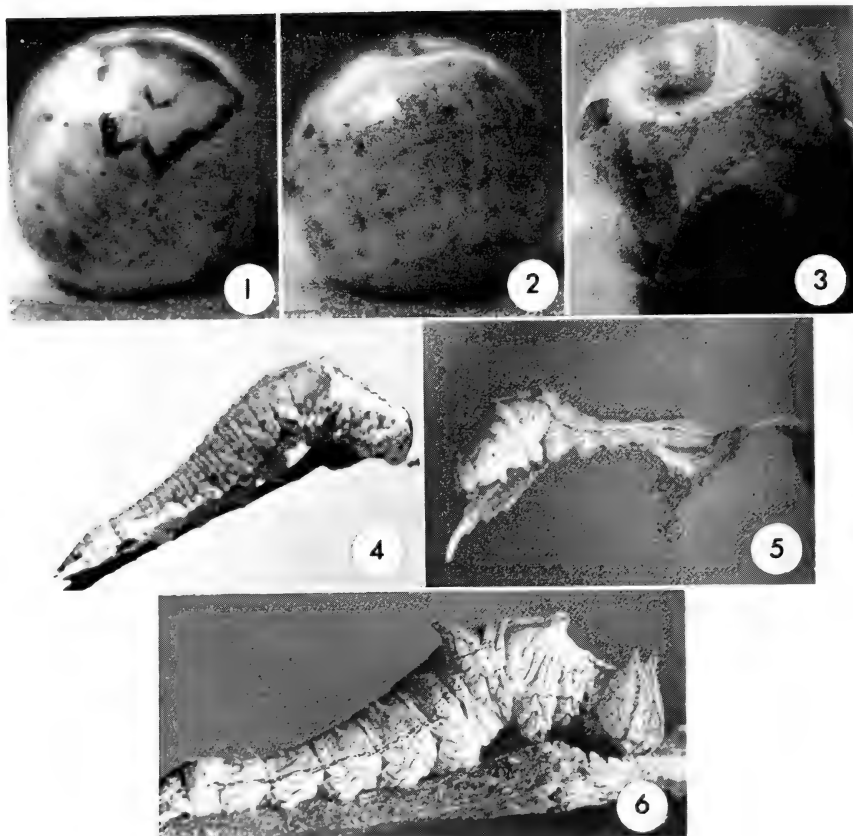
The rearing was done inside transparent plastic bags. The larvae were kept supplied with fresh leaves of the foodplant. The plastic bags were cleaned daily of excess moisture and excreta. Shortly before pupation, the larvae were transferred to a wooden box with mosquito-net windows. The adults emerged in the same box. Measurements of the different instars were recorded, and photographs were taken of all developmental stages. Some specimens of the early stages and exuvia were preserved in alcohol. These will be sent to the American Museum of Natural History, New York. The adults were determined by Dr. A. H. B. Rydon, the foodplant by Dr. D. Burch, University of South Florida.

LIFE CYCLE

Egg (Figs. 1, 2). White, spherical but for slightly flattened base, smooth, no visible sculpturing at 15 \times magnification, 2.5 mm diameter. When ready to hatch in 6 days, head and body marks visible through eggshell.

First instar larva (Fig. 4). General color pale brown. Head roundish, naked, with a dark brown M mark on front. Naked body thickens from head to 2nd abdominal segment, then narrows caudad, terminates in two short tails. Prominence on dorsal meson of 3rd thoracic segment, another subdorsally on each side of 2nd abdominal segment directly above corresponding spiraculum. Thoracic segments with fine, dark brown lines. Abdominal segments darker brown dorsally. Anal prolegs smaller than others. Thoracic spiraculum larger than abdominals. Second abdominal spiraculum very high, completely out of line from others, except that 8th abdominal spiraculum also slightly higher. Grows from 4–10 mm in 13 days.

Second instar larva (Fig. 5). Head with same aspect as in first instar except for one short horn on each epicranial apex. Body also as in first instar except dorsal hump more noticeable and tails longer and straight. Grows to 14 mm in 8 days.

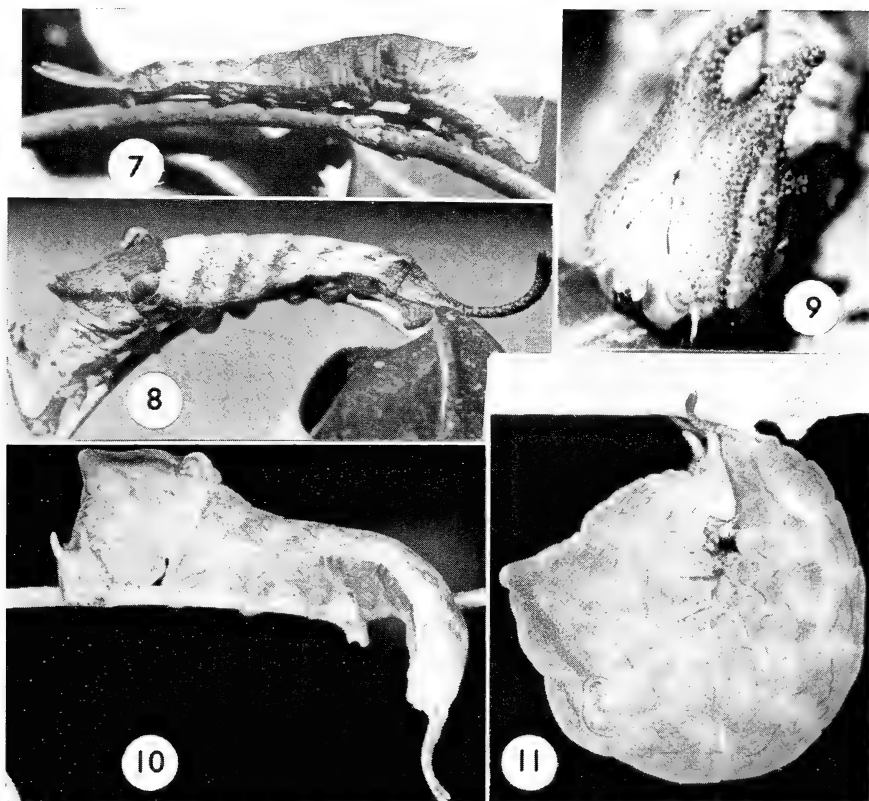


Figs. 1-6. *Archaeoprepona demophon centralis*. 1, Egg showing characteristic M on larval head, width about 2.5 mm; 2, egg showing dorsal markings of the larval body; 3, egg parasitized by larvae of an unknown Chalcididae; 4, first instar larva, about 6 mm long, on resting perch; 5, second instar larva, about 14 mm long, baring a vein; 6, third instar larva, about 27 mm long.

Third instar larva (Fig. 6). Same general colors as earlier. Head with longer horns; appearance of small, blunt, lateral projections below and behind horns. Mesal projection on 3rd thoracic segment and subdorsal ones on 2nd abdominal segment very pronounced. Dark brown line separating dorsal darker area from paler subspiracular area which is criss-crossed by faint brown lines as is the thoracic zone. Caudal projections longer, still straight. Grows to 30 mm in 8 days.

Fourth instar larva (Fig. 7). Head and horns covered by small tubercles, producing a coarse aspect; lateral projections more noticeable. Body color darker, mostly over supraspiracular and dorsal areas, darker slanting lines. Appearance of tiny, bright blue spots along spiracular zone, around mesal prominence on 3rd thoracic segment and on longer, slightly crooked tails. Grows to 48 mm in 13 days.

Fifth instar larva (Figs. 8, 9). Head and horns much rougher, lateral projections quite noticeable. Body color brown on thoracic segments and subspiracularly on

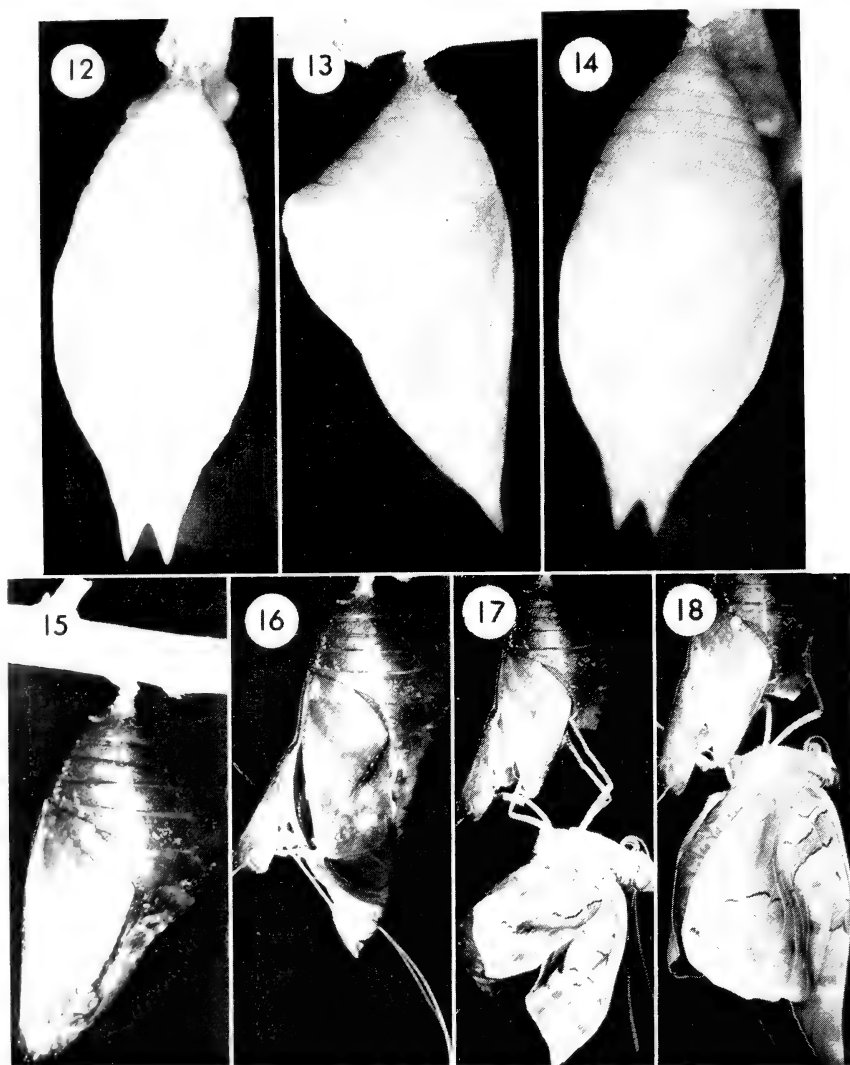


Figs. 7-11. *Archaeoprepona demophon centralis*. 7, Fourth instar larva crawling, about 45 mm long; 8, fifth instar larva recently moulted, about 50 mm long; 9 detail of head of fifth instar larva; 10, prepupa in typical resting position, about 72 mm long; 11, prepupa ready to pupate, notice placement of tails.

abdominal segments. Dark brown triangle dorsally covering area limited by 3 very prominent projections on 3rd thoracic and 2nd abdominal segments. Dorsa of remaining segments from spiracular line to meson, paler brown with darker brown slanting bands. Tails dark brown with yellow spots, very long and crooked. Profusion of tiny, bright blue spots on tails, along spiracular line and around thoracic prominence. Prolegs very thick. Grows to 70-80 mm in 18 days.

Prepupa (Figs. 10, 11). Drastic color change. Head and body green, darker on head, thoracic prominence and along spiracular line from 6th-9th abdominal segments. Blue spots still visible.

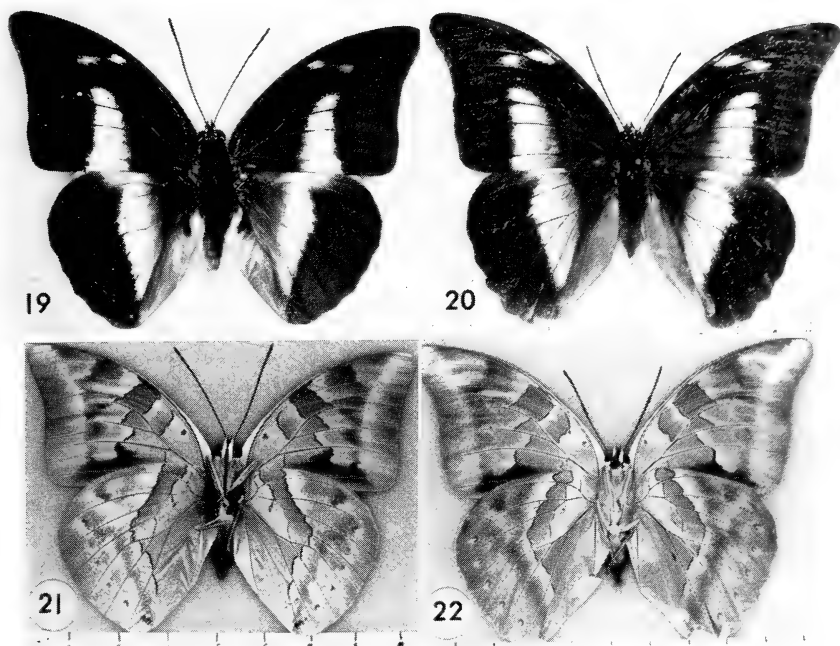
Pupa (Figs. 12-14). Bluish-green with scattered whitish, irregular spots; head bifid with points yellowish. Spiracula light brown surrounded by white ovals. Prior to adult emergence becomes very dark gray, some adult colors visible through cuticle. Lateral view: ventral profile only slightly convex; dorsal profile widens gradually from green cremaster to 5th abdominal segment, then the 4th forms a distinct hump, then narrows gradually to bifid head. Dorsal and ventral aspect: lateral profile widens smoothly from cremaster to wingcases, at thoracic level, then



Figs. 12-18. *Archaeoprepona demophon centralis*. 12, Pupa, ventral aspect, about 42 mm long; 13, pupa, lateral aspect; 14, pupa, dorsal aspect; 15-18, sequence showing emergence of adult male.

narrows abruptly to head. Measurements: 42 mm long, 18 mm laterally, and 20 mm dorso-ventrally at widest points.

Adult (Figs. 19-22). Males and females shaped similarly. Forewing with faintly convex costal margin forming a rounded apex, concave outer margin to rounded tornus, straight inner margin. Hindwing with convex costal margin, strong humeral lobe, rounded outer angle continuing with rounded outer margin to



Figs. 19–22. *Archaeoprepona demophon centralis*. 19, Adult male, dorsal view, wingspan about 82 mm; 20, adult female, dorsal view, wingspan about 103 mm; 21, adult male, ventral view; 22, adult female, ventral view.

rounded anal angle, rounded inner margin with a fold. Dorsal ground color of forewing dull black in males, dark brown in females, with a greenish-blue iridescent isosceles triangle from median area of wing with base on mid-inner margin; 2 small subapical, bluish spots. Hindwing with small basal, black triangle and broad, greenish-blue iridescent band from mid-costal margin ending in a point near inner margin, close to anal angle; this band with definite pale blue tinge along basal border. Inner fold and thin border along costal margin, pale gray. Males with black brush of hairs near base of hindwing. Ventrally, dominant color pale brown with complicated pattern of darker brown areas and thin black lines; along outer margin of hindwing a row of small “eyes” with light blue pupils. Antennae and eyes black, proboscis orange. Dorsal and ventral surfaces of body concolorous with corresponding wing surfaces. Wing span 80 mm in males, up to 105 mm in females.

Total developmental time for this species 85 days.

NATURAL HISTORY

The females of *Archaeoprepona demophon centralis* deposit their eggs singly on the lower surfaces of the mature leaves of a shrub determined by Dr. D. Burch to be at least very close to *Malpighia glabra* L. (Malpighiaceae). The pure white egg is quite visible against the dark green leaf.

The newly hatched larva completely consumes the eggshell, leaving only the shiny base on the leaf, and stays for one day without further feeding. It then moves to the tip of the leaf and nibbles around the central vein, baring it and affixing to it small, frass pellets woven with silk until the vein is prolonged beyond the leaf limits. Pieces of leaf tissue hung from short lengths of silk are added to the resultant perch. This is used as a resting perch during the day where the small larva is very inconspicuous among the dried bits of leaf. It is abandoned by the larva only momentarily to feed at dawn or dusk. First, second and third instar larvae use a perch. If the leaf is consumed during this period, another perch is made on a second leaf, and in some cases, a third. From the fourth through fifth instars, the larva wanders about the plant, but usually stays motionless during the day resting on a twig, head and tail hanging at the sides, giving the dorsal anterior part of the body a reptilian appearance (i.e., head of small snake or lizard) with the prominences on the second abdominal segment resembling the eyes and the mesal prominence on the third thoracic segment, the snout. The effect is enhanced by the crawl of the larva which imitates an inquiring snake head. The mesal prominence on the third thoracic segment is retractile; when touched it almost disappears.

The prepupal larva becomes green and very inconspicuous, blending with the green foliage. At this time, the larva wanders for two days searching for a suitable pupation site which may be on the same food-plant. Once the site has been chosen, usually a twig, the larva weaves a silk pad girdling the twig, reinforcing the twig's attachment to the shrub. The anal prolegs are then applied to the pad, the tails are positioned on either side of the twig, and the larva hangs incurved ventrally with its head almost touching the anal prolegs. It hangs thus for two additional days.

The pupa is also very cryptic due to its green color which matches the foliage. It is very passive, but when roughly handled it reacts by swinging laterally and then returning to the vertical position. The pupal color changes to very dark gray shortly before the adult emerges. Some of the adult colors are actually visible through the pupal cuticle before emergence occurs.

The adult emerges rapidly and hangs from the smoky gray pupal cuticle while expanding its wings and ejecting the meconium (Figs. 15-18). The adult is ready to fly in about 25 minutes.

The adults of *A. demophon centralis*, like most Charaxinae, are strong, swift fliers, producing an audible rustling noise at short distance. They usually keep to tree-tops and come to the ground only to feed on fer-

menting fruits (e.g., mangoes and guayabas) or vertebrate excrement. Both sexes are lured easily to baits of fermented banana. They also feed on sap oozing from tree wounds. The male exhibits a strong territorial behavior and perches on its chosen tree, chasing vigorously any trespassing butterfly. The female flies at lower levels, mostly when ready to oviposit. We have observed *A. demophon centralis* most frequently around wooded coffee plantations from 600–1200 m elevation.

The foodplant, *Malpighia glabra* L. (?), is found most commonly in wooded ravines within the flight range of the adult. It is a small shrub with perennial, opposite, stipulate, ovate leaves and pinkish flowers with characteristic dentate petals arranged in cymes. The fruit is a red drupe when mature with up to 3 carpels.

It was observed that the eggs of *A. demophon centralis* are very often parasitized by Chalcididae wasps (Fig. 3), and the very young larvae are preyed upon by spiders.

Discussion

Species belonging to the genus *Archaeoprepona*, prior to its establishment by Fruhstorfer in 1916, were placed in the genus *Prepona* Boisduval (Hemming, 1967). The type species for *Archaeoprepona* was designated as *demophon* Linnaeus. Le Moult (1932) chose to ignore Fruhstorfer's genus and established the invalid synonym *Pseudoprepona* with *demophon* again as the type species. Some modern authors (e.g., Descimon, et al., 1973) consider *Archaeoprepona* to be a subgenus of *Prepona*.

Basic differences in the adults: black hair tufts on the hindwing of *Archaeoprepona*, against the honey-colored tufts of *Prepona* and the male genitalic differences and antennal colorations as noted by Fruhstorfer (1916) consistently correspond to morphological differences during the larval and pupal stages. The data pertaining to the immature stages are found in a number of sources. Included are the descriptions of the early stages made by Müller (1886) of *Archaeoprepona amphimachus* Fabricius, *A. catachlora* Staudinger, *A. demophon extincta* Staudinger (all under the generic name *Prepona*) and *Prepona laertes* Hübner. Lichy's (1933) description of the early stages of *Prepona omphale guatemalensis* Le Moult and that of *P. omphale octavia* Fruhstorfer by Muyschondt (1973a) also are important sources. In addition to the above life history of *Archaeoprepona demophon centralis*, another study that will soon be published on a yet, undetermined species of *Archaeoprepona* is taken into consideration.

All the descriptions of the mentioned *Prepona* species show that the two horns on the head are fused and appear as a single epicranial pro-

jection. The *Archaeoprepona* species have two distinct horns, one on each epicranial apex plus a shorter horn below and behind each large epicranial horn. The general habitus of the larvae of both groups is similar except *Prepona* species lack the median dorsal prominence on the third thoracic segment which is present in all known *Archaeoprepona* larvae. *Prepona* larvae do not show the drastic color change when entering the prepupal stage which we noticed in rearing *Archaeoprepona demophon centralis* and the undetermined *A. sp.* Müller's (1886) descriptions make no mention of prepupal color changes. The pupae of *Prepona* gradually are humped dorsally while *Archaeoprepona* species show a very pronounced hump on the fourth abdominal segment. Also the pupae of *Prepona* have orange, irregular spots; these are white in *Archaeoprepona* pupae.

All these differences favor the concept of two genera, but the many similarities, including behavioral patterns, indicate that both genera belong under the same immediate higher classification. On the same basis it also is very evident that these genera are closely related to the *Zaretis-Siderone* complex (Rydon, 1971; Muysshondt, 1973b and ms. in prep.). These facts seem to be in agreement with Rydon's treatment of the Charaxidae (with family status) which, in addition to other subfamilies that include Old World genera, separates the American genera into three subfamilies: Preponinae (*Prepona*, *Archaeoprepona*, *Agrias*, *Anaeomorpha* and *Noreppa*), Zaretidinae (*Coenophlebia*, *Zaretis* and *Siderone*) and Anaeinae (*Fountainea*, *Hypna*, *Anaea*, *Polygrapha*, *Consul*, *Cymatogramma* and *Memphis*) with Zaretidinae being the link between Preponinae and Anaeinae.

Some authors have tried to prove close phylogenetic relations between the Charaxinae and other groups, e.g., Limenitinae (Reuter, 1896; Müller, 1886). According to Fruhstorfer (1924), Hahnel thought there was an affinity between *Prepona* and the Apaturinae. If the consensus is followed that the more reliable morphological characters to determine phylogenetic relationships are those which resist, to a greater degree, changes induced by selection, and these are the characters of the early stages (Brower, et al., 1963), it appears that neither the Limenitinae nor the Apaturinae show much in common with the Charaxinae, nor with any other group of the Nymphalidae. Rydon (1971) may be right in assigning family status, as other authors have also done, to the Charaxinae. The smooth, spherical eggs (flattened base and micropylar area or not), the spineless (Dornenlossen of Müller [1886]) larvae and the peculiar pupae of this group have nothing in common with either the very sculptured (pineapple-like) eggs, the odd-looking, spine-covered larvae or the

pupae with characteristic projections of the Limenitinae. In a series of future articles observations on the local *Adelpha* (Limenitinae) will emphasize this point. The spherically ribbed eggs and the flattened pupae of the Apaturinae do not have much in common with the Charaxinae either. It is true that the Charaxinae show some behavioral similarities with other nymphalids (e.g., the making of resting perches during the larval stage, adult feeding of fermenting fruit, etc.), but this might very well be the result of selective forces producing independently convergent successful strategies in species otherwise distantly related as is the case in many color similarities between species forming Müllerian mimicry complexes.

It frequently happens that during the larval stage of a given species (e.g., *Morpho peleides* Kollar, *Dione moneta* Hübner, various *Apatura* spp. and *Smyrna blomfieldia* [Fabricius] in particular), or during the pupal stage (e.g., *Opsiphanes tamarindi* Felder, *O. cassina* Felder, *Zaretis itys* [Cramer], and *Anaea euryppyle* [C. & R. Felder]), there are very noticeable differences in coloration even though during the early stages there should be less chance for diversification. There are also differences of this sort in the adults of the same species, even coming from the same brood. We once obtained three adult males of *Morpho peleides hyacinthus* Butler, with four "eyes" on the ventral side of the forewing while another 18 specimens, males and females, only had three as is common. All 21 specimens were from eggs deposited by the same female on the same date in our insectary. They were fed their normal foodplants and were kept under identical conditions until adult emergence. Le Moul't's (1932) opinion was that species of *Prepona* and *Archaeoprepona* are less variable than their near relatives, the *Agrias*, and have stable external characteristics. According to Dr. Descimon (pers. comm.), the numerous new species and subspecies that Le Moul't named on the basis of external characteristics has caused great confusion. Vane-Wright (1974) thought many of Le Moul't's taxonomic conclusions were unsound because he "split" many previously accepted species on little evidence.

Much "lumping" and "splitting" has been done in the past without having enough data to form sound conclusions. It is important that more investigations on the early stages of the neotropical Rhopalocera be conducted so that systematists can use the results to establish a more accurate scheme of classification.

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NEW *CATOCALA* OF NORTH AMERICA (NOCTUIDAE)

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All but one of these species fall in our two most difficult groups of the small *Catocala*—the *crataegi* group in the East and the *andromache* group in the West, though when we really know the early stages of all species, further division may be indicated. I have spent a great amount of time and work mounting specimens, preparing genitalia and studying these genitalia to arrive at only indefinite characters based on structure on which to separate the species. The adults vary throughout their range and in some local areas noticeably different specimens occur. The great need is for adequate material of eggs, larvae and pupae of all species to be available for comparison, and in the adults, a series from many scattered places in its range. Larval descriptions in the *crataegi* group are tenuous or non-existent, and nothing seems to have been published on the early stages of any of the *andromache* group, except *cheli-donia* Grote. With probably the greatest series in existence of these species and closely related ones before me, I believe all of the following proposed species warrant the title new species, when a series is closely studied. For many years specimens of the *andromache* group have been sought by two experienced workers, J. W. Johnson and Erich Walter, and several females of each of several species have been confined for eggs, without securing an egg. The series of specimens have been possible only through the generous help of collectors and the institution named in connection with types. Unless otherwise stated all types remain in the author's collection at present.

***Catocala texarkana* Brower new species**

(Fig. 1)

The forewing is of a light uniform gray, somewhat darker basally, and along the inner margin, the basal area in the fold toward the transverse anterior line with definite ribbing. The median area from costa to inner margin or to fold is conspicuously whitish, with a segment of a median line to the reniform usually present, and some darker shading between the reniform and transverse posterior line. The lines are narrow, brownish black, with a few short teeth or rounded bows; the basal half-line is faint with an outward angle and a rounded bow to its end; the t.a. line is heavy black, with additional black shading basally, of short zig-zags to the fold, thence toothed inward and then somewhat outwardly bowed to inner margin; the t.p. line is fine, scarcely toothed except for the short two large teeth, thence an inward arc to the blacker horizontal segment in the fold, thence bowed outward to the inner margin; and subreniform usually separate, irregular, small; the grayer reniform rather small, upright, set out by an irregular, conspicuous white border:

beyond the t.p. line a variable brown band is present, followed by a faint white subterminal line; a terminal line of shallow crescents; from the large teeth of the t.p. a dark dash to below the apex. The hindwing is orangish yellow; the outer band moderate, leaving a small yellowish to orangish apex, and is usually broken before anal end, swollen toward the upper end and again in the M_2 -Cu area; this bends and extends to the base of the wing. Beneath, the hindwing repeats the upperside, except paler; the forewing is as usual. The species *texarkana* is most readily separated from other species of the *crataegi* group, when, with its form *bridwelli*, it is compared with them in series. I name this form *bridwelli* (Fig. 2) after L. H. Bridwell who reared from *Crataegus* many specimens of both forms. The type ♂ of *bridwelli*, Forestburg, Texas, 1200 ft., 13 May 1939. In addition 32 specimens have been set aside as this form. It is characterized by a much blacker basal area including a heavy black t.a. line, some becoming browner and grayer toward the base. The types have the lighter gray median area continued to the inner margin, but many of this form have the inner margin darker, in an extension of the basal area.

Holotype. ♂, Forestburg, Texas, 1200 ft., 10-12 May, 1940, L. H. Bridwell, probably reared from larvae beaten from *Crataegus*.

Allotype. ♀ ditto, 13 May, 1939, reared from *Crataegus*.

Paratypes. 40 ♂ and 42 ♀; Forestburg, Texas, 12 ♂, 15 ♀, May 1939, mostly reared; Forestburg, May 1940, 28 ♂ and 25 ♀; Lincoln Co., Arkansas, May 3 and 4, 1938, 2 ♀; all L. H. Bridwell. From other localities I have the following: a ♂ labelled "Texas", W. N. Tallant collection; a ♀ College Station, Texas, April 19, 1929; a ♂ Churchill Bridge, Brazoria Co., Texas, 3-V-1968 (A. and M. E. Blanchard); all three too poor to include in the types. The Blanchard's showed me the Churchill Bridge collecting locality when I visited Houston.

Expanse (part reared) of a series of each: ♂ 41 mm.; ♀ 43 mm.

***Catocala lincolnana* Brower new species**

(Fig. 3)

Lincolnana is a simply marked species, brownish gray on basal, apical, and anal areas, and along inner margin beyond transverse anterior line; the remainder light gray with some brown. The basal half-line is evident, the transverse anterior line is heavy, black, of short zig-zags, nearly straight and oblique to the inner margin; the reniform, a small upright oval, fringed with white; the subreniform irregular, rather large, and separate; the transverse posterior line is fine, shortly toothed, largely transverse to the fold, when a long inward segment carries it to near the t.a. line. The subterminal line of lighter short hastae is evident, the terminal line of short bars scarcely evident. The hindwing above is as usual in the *Crataegus*-feeders, with a larger orangey apical area, a large oval black spot before the anal angle; the median band a bit narrow and extending to the base; this pattern repeated below on the hind wing and the usual pattern beneath on the forewing.

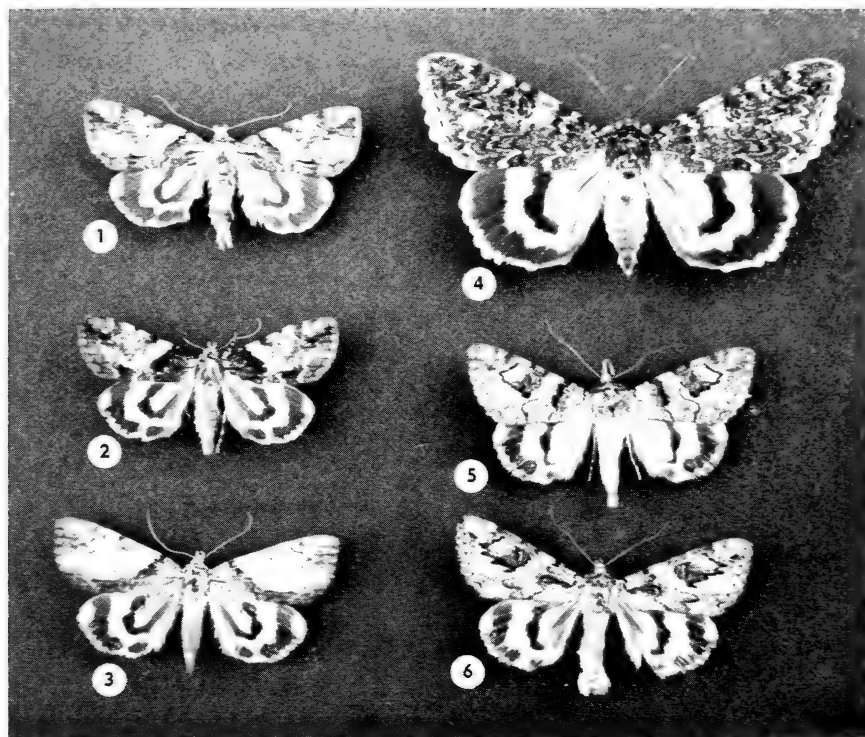
Expanse: ♂ 47 mm.

Holotype. ♂, Lincoln Co., Arkansas, 1 June 1937, L. H. Bridwell. Type in author's collection.

***Catocala johnsoniana* Brower new species**

(Fig. 6)

The ground color of the forewings is ashy gray with prominent black lines. Beyond the transverse anterior line, from the costa a darker oblique shade passes across the reniform and on to the transverse posterior line above the subreniform;



Figs. 1-6. *Catocala* species. 1, *Catocala texarkana*, Forestburg, Texas, 10-12 May 1940, ♂, holotype; 2, *C. texarkana* form *bridwelli*, Forestburg, Texas, 13 May 1939, ♂; 3, *C. lincolnana*, Lincoln Co., Ark., 1 June 1937, ♂, holotype; 4, *C. erichi*, Green Valley Creek, San Bernardino Mts., Calif., ex ovum, 19 May 1966, ♂, holotype; 5, *C. californiensis*, Valyermo, Los Angeles Co., Calif., 27 June 1957, ♂, holotype; 6, *C. johnsonana*, Kernville, Kern Co., Calif., 17 June 1965, ♂, holotype.

beyond and above the reniform a less defined paler blotch extends to the t.p. line. The basal half-line is black and transverse; the t.a. line is heavy and black, nearly straight to Cu_2 , then curved and tapered to A_1 , thence obliquely outward to inner margin. The basal dash is present. The t.p. line extends outward on R, then barely toothed to most outward point, thence with three short acute teeth to the loop forming the small pale subreniform (open, closed, or disconnected), thence strongly curved to A_3 and nearly direct to the inner margin. The subterminal line is whiter gray, the terminal line of connected crescents. The fringes are gray. The medium-sized inconspicuous reniform is commonly darker-centered and outlined by paler scales. The hindwing above is orangish yellow, the outer black band well developed with an apical patch of ground color, usually a small spot broken off before the anal angle; median black band narrowed, with an outward bulge on R and a second one M_2 to Cu_2 , little tapered, usually but little turned inward and ending bluntly. Beneath, the forewing is pale yellow with the usual dark and light areas; the hind wing orangish yellow; the outer black band medium

width, with small apical area of ground color, usually unbroken. The median band rather narrow, oblique, nearly even, until M_2 , when set out more than width of band, soon narrowed, the very end of the terminal portion turned toward inner margin, and ending abruptly.

Expanse: ♂ 49.5 mm.; ♀ 52 mm.

Holotype. ♂, Kernville, Kern Co., Calif., 17 June 1965 (Erich Walter).

Allotype. ♀, Kern River Canyon, Kern Co., Calif., 29 May, 1954 (Wm. A. Rees).

Paratypes. 5 ♂, 1 ♀: Kern Canyon, Kern Co., Calif., elevation 2800 ft., 29 May, 1954 ♂ (C. A. Hill); Kernville, Kern Co., Calif., 2500 ft., 16 June 1965 ♂, 21 June 1965 2 ♂ (Erich Walter); 18 June 1966 ♂ (J. W. Johnson and E. Walter); Hughes Lake, Los Angeles Co., Calif., 23 June 1971 ♀. Holotypes and paratypes collection A. E. Brower. Allotype and part of paratypes returned to Natural History Museum, Los Angeles.

***Catocala californiensis* Brower new species**

(Fig. 5)

The ground color of the forewings is ashy gray, varying from light to brownish gray, with a broad lighter band from costa beyond the transverse anterior line to the subreniform, and including a still whiter gray subreniform; with a black shade from mid-costa over reniform to strongly inbowed transverse posterior line, which has short stout teeth on M_1 and M_2 with a short tooth inward on the fold. The lines are heavy black, especially the transverse anterior line, which is nearly straight to the fold; the t.a. set out by a paler gray basal edging, the t.p. less so by an outer paler line; the basal half-line black, somewhat jagged; the basal dash absent; a more or less evident subterminal band of lighter sagittate marks; the terminal black scalloped band is usually continuous; the fringes gray. The hindwing above has the inner black band narrow, nearly straight, swollen outward from M_2 to Cu_2 , then greatly attenuated and sharply angled inward toward the inner margin; the outer band of moderate width, usually broken before anal end, and with a yellow patch before apex. Beneath, both wings are much paler, the forewing with the usual pattern, and the hind wing a duplication of the upper side.

Expanse: ♂ 46 mm.; ♀ 47.5 mm.

Holotype. ♂, Ranch two and one half miles south-southwest of Valyermo, Los Angeles Co., Calif., 4800 ft., 27 June 1957 (Noel McFarland).

Allotype. ♀, Pinyon Flats, Santa Rosa Mts., Calif., 10 July, 1967, ultra-violet light, (J. W. Johnson and Erich Walter).

Paratypes. 10 ♂, 11 ♀: near Acton, Mint Canyon, Los Angeles Co., Calif., 3 June 1950 ♂ (Chas. A. Hill); Tujunga, Los Angeles Co., Calif., 26 June 1940 ♀ (C. Henne); ranch two and one half miles south-southwest of Valyermo, Los Angeles Co., Calif., 4800 ft., 26 June 1957, 3 ♂, 3 ♀, and 1 July 1964 ♀ at black light (Noel McFarland); nine miles southeast of Pearblossom, Los Angeles Co., Calif., 27 June 1947 ♂ (Noel McFarland); Pinyon Flats, Calif. [Santa Rosa Mts.], 5 July 1970 ♂, 16 July 1967 ♀ (the last two J. W. Johnson handwriting); Pinyon Flats, Santa Rosa Mts., Calif., 4000 ft., 3 July 1970 ♂, 10 July 1967 2 ♂, 1 ♀, 11 July 1967 1 ♂, 3 ♀, ultra-violet light, 16 July 1969 ♂, 18 July 1968 2 ♀, ultra-violet light (J. W. Johnson and Erich Walter).

***Catocala erichi* Brower new species**

(Fig. 4)

The forewings are black, tinged with brown, appearing more or less overscaled with somewhat smaller white scales with a bluish sheen, best developed in the median area. Basal half-line of black inner, and white outer lines; transverse anterior line, strongly zig-zag of white inner and black outer portions, appearing black on

both sides; before and somewhat below the reniform is a striking white patch, and another in the median area between the inward bulge of the transverse posterior line and the subterminal line; the apical area is brownish black, and from it to the outer angle the margin is variably gray and white; the reniform is rather large, upright, irregular, vague, partially outlined with black and may be more so outside with white; the subreniform is usually separate, lighter with brownish overshading; the transverse posterior line is short-toothed, largely transverse, black inside, white outside; the subterminal line, of short broad white chevrons, is prominent; the terminal line is of short bars or shallow crescents; terminal dark crescents form a more or less continuous line at the base of the fringe. On some the black obscures all except the two white patches and the subterminal line. The hindwings are deep red with strong black bands, with white to pink margined apices; the median black band more or less abruptly ending or greatly contracted with the narrowed end turned upward, with long black hair near base of wing. Beneath, on forewing the wings are much paler with the bands as usual, and on hindwing a paler reproduction of the upper side. During separated years broods of this species were reared from eggs and with caught specimens form an unusually similar series of specimens, well separated from *francisca* Hy. Edwards, and from the more northern complex of *mariana*, Hy. Edwards, *edwardsi* Kusnezov and *eldoradensis* Beutenmüller. Larvae of *erichi* (named for the chief collector), two broods, lost in the last instar the dark brown patch on the abdominal hump, while larvae of *francisca* kept their patch.

Expanse (nearly all reared); ♂ 66 mm.; ♀ 68 mm.

Holotype. ♂, emerged 19 May 1966, reared by J. W. Johnson, ova Green Valley Creek, San Bernardino Mts., Calif., 7000 ft., Aug. 1965 (E. Walter).

Allotype. ♀, San Bernardino Mts., Calif., 7000 ft., reared by J. W. Johnson, emerged May 1971, ova by E. Walter summer of 1970.

Paratypes. 11 ♂, 8 ♀: Green Valley Creek, San Bernardino Mts., Calif., 7000 ft., ova from female August 1965 by Erich Walter, reared by J. W. Johnson and Erich Walter, adults emerged May 18 until June 21, 1966, 4 ♂, 3 ♀. Of a second lot of ova, summer of 1970, by Erich Walter, reared by both Johnson and Walter in 1971, 4 ♂, 3 ♀ emerged late June to July 27; Hathaway Creek, near Barton Flats, San Bernardino Mts., Calif., 2 August 1940 ♂ (C. Henne); Camp Oongo, near Running Springs, San Bernardino Mts., Calif., 28–31 August 1967 ♀ (C. L. Hogue). Types at present in my collection, paratypes returned to Natural History Museum, Los Angeles, J. W. Johnson and Erich Walter.

A CHECKLIST OF THE BUTTERFLIES OF GRANT COUNTY, NEW MEXICO AND VICINITY¹

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Little has been published on the butterflies of New Mexico, although the type localities for several species lie in the northern and western portions of the state. Early collecting by H. Skinner and J. Woodgate and later collecting by A. B. Klots forms the basis for much of what we know about its butterfly fauna. Collecting in recent years by D. Cowper, R. Holland and M. E. Toliver has expanded our knowledge. Williams (1914), Hubbard (1965), Toliver (1971) and Holland (1974) have published papers which treat limited geographic areas within New Mexico.

Since 1965, the author has collected actively in the southwestern portion of the state, primarily in Grant County, with some additional collecting in Catron, northern Hidalgo, Luna and western Sierra counties. The area so defined comprises a fairly uniform faunistic region. Although records are available from the Peloncillo Mts. in Hidalgo Co., they are not included as another faunistic region is involved. Hubbard's paper lists butterflies from the Pinos Altos Mts. which lie in Grant Co. His list of 52 species, which excludes the Hesperioidea, represents only a part of the 157 confirmed species in the current study. A checklist of the presently known species appears in a subsequent section of this paper.

Localities

Most of the collecting was in various areas of the Gila National Forest, on several ranches and with scattered collecting in the desert areas south and southwest of Silver City. The primary forest collecting sites include: the Burro Mts. south of Silver City; the Black Range east of Silver City; Cherry Creek Canyon (Pinos Altos Mts.), Signal Peak and Lake Roberts north of Silver City; and the Mogollon Mts., especially the Willow Creek area, in Catron Co. Sonoran desert localities include: along the Gila River, especially in the vicinity of Red Rock; along State Road 90 between Lordsburg and Silver City; vicinity of Faywood Hot Springs and City of Rocks State Park; and Hachita.

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Vegetation types of the region are quite varied. Collecting sites in the Mogollon Mts. are generally open Canadian Zone meadows associated with live streams, usually a ponderosa pine (*Pinus ponderosa* Laws.) and willow (*Salix* sp.) association containing a variety of grasses, herbs and shrubs. The Black Range and sites north of Silver City are generally Transition Zone associations with ponderosa pine, pinyon pine (*Pinus monophylla* Torr. & Frem.), Douglas fir (*Pseudotsuga taxifolia* var. *glauca* [Mayr] Sudw.) and aspen (*Populus tremuloides* Michx.) at the higher elevations, and at lower elevations a variety of deciduous trees and shrubs including *Acer*, *Alnus*, *Celtis*, *Cercocarpus*, *Crataegus*, *Prunus*, *Populus* sp. (cottonwood), *Rhus*, *Salix* and *Platanus wrightii* S. Wats. Grasses and herbs abound, especially near permanent water. Canadian Zone vegetation occurs at higher elevations, especially on Signal Peak 9000'. The Burros Mts. are covered primarily with pinyon pine, alligator juniper (*Juniperus deppeana* Steud.) and Emory Oak (*Quercus emoryi* Torr.); several other species of oak are also present. *Acacia greggii* Gray, *Chilopsis linearis* (Cav.) Sweet. and *Prosopis juliflora* (Swartz) DC. occur at lower elevations. Principal vegetation types in the desert areas include grasses, *Acacia*, *Agave*, *Chilopsis*, *Prosopis*, *Yucca* and various cacti. Cottonwood, hackberry (*Celtis* sp.) and other deciduous trees are associated with riparian areas, and outcroppings of oak are common.

Annual rainfall in the Silver City area averages 0.406 meters. The principal moisture occurs in the months January–March, July–October, with the heaviest precipitation during the summer months. July is usually the wettest month and May the driest. The mean temperature is 12.67°C with average highs and lows of 28.55°C and -4.83°C respectively.

Specific collecting sites with alphabetic codes are given below. In several cases where only one or two records are from a locality, no code is used and the localities are clearly shown on the maps (Figs. 1 & 2). Either the code letters or the locality name appears on the maps.

CATRON COUNTY. Whitewater Creek and Catwalk area near Glenwood 4800' (CA); Datil ca. 7000' (D); Gila Cliff Dwellings and EE Canyon 5600–6100' (EE); Frisco Hot Springs 4500' (FS); Glenwood 4700' (G); Gila Wilderness Area (varying elevations) (GW); Gilita Creek 7800–8000' (GK); Little Creek and Gila River Junction 5750 (LC); Luna 7000' (LN); Mogollon 6600' (M); Pleasanton 4600' (P); Pie Town ca. 8100' (PT); Quemado Lake 7200' (QL); Reserve ca. 5800' (R); Silver Creek, crossing at State Road 78 8560' (SK); SS Basin T10S, R15W, S21 7600' (SS); Willow Creek (camp area) 1800' (WC).

GRANT COUNTY. Ancheta Canyon 5800–6400' (AC); Ash Spring Canyon 6700–6900' (ASC); Bayard 5880' (B); Black Canyon Camp 7000' (BC); Bill Evans Lake 4700' (BE); Burro Mountains (Homestead Road and USFS 851) ca. 6650' (BM); Bear Mountain 6500–7000' and Bear Mtn. Ranch 6250' (BR);

Cliff 4500' (C); Copperas Canyon 6000-7400' (CC); Cherry Creek Canyon and McMillen Canyon 6700-7300' (CCC); Cottonwood Canyon 6300' (CN); Dry Gallinas Canyon 6800' (DGC); East Canyon, Black Range 7400' (EC); USFS 152, Black Range (varying elevations) (F); Ft. Bayard, E. of Silver City 6000-6200' (FB); Faywood Hot Springs 5000' and City of Rocks State Park 5200' (FH); Fierro 6600' (FI); Gallinas Canyon area, Black Range 6800-7000' (GC); Gold Gultch 5800-5900' (GG); Gila River near Gila 4250' (GR); East Fork of Gila River ca. 6000' (GRE); Hachita 4100' (H); Hachita Mountains 4800-6000' (HM); Iron Creek Camp, Black Range 7100' (IC); Kneeling Nun Vista, Black Range 6990' (KN); Killeylekia Ruins 4550' (KR); Lower Gallinas Canyon 6400-6800' (LGC); Lake Roberts 6000' (LR); L-S Mesa, north of Silver City, USFS 853 6200-6500' (LS); Little Walnut Creek 6600' (LW); Mule Creek area, Jupe Means Ranch 5800-6300' (MC); Mill Creek Canyon 6800-7100' (MI); Mogollon Creek 4640' (MK); Moon Ranch 5200' and Buckhorn 4800' (MR); Pinos Altos 7000' (PA); Pine Cienega 6500' (PC); Ricolite Canyon near Red Rock 4200' (RC); Red Rock 4000' (RR); Sherman 5600' (S); SA Canyon, Gila Wilderness Area 6800-7400' (SA); Silver City 5900-6100' (SC); Sapillo Creek 5800-6200' (SE); San Lorenzo 5800' (SL); Skate's Canyon 6600' (SN); Soldier Canyon 6300' (SO); Signal Peak 8000-9000' (SP); State Road 90, milepost xx between Silver City and Lordsburg (SR-xx); Santa Rita 6500' (ST); Tyrone 5700-5800' (T); Thunderbird Camp (1 mi. N) 6500' (TC); Upper Gallinas Canyon 7000' (UGC); Vanadium 5950' (V); White Signal (vicinity) 6000' (WS).

HIDALGO COUNTY. Animas 4300' (A); Animas Valley 4700-5100' (north-south) (AN); Deming ca. 3000' (DM); Lordsburg (vicinity) 4240' (L).

LUNA COUNTY. Columbus (vicinity) 4000' (CO).

SIERRA COUNTY. Emory Pass area 8200' (EP); Kingston 6250' (K).

Checklist

In the list of species which follows, the counties and localities are noted as well as the months in which specimens have been taken. Additional comments are appended when applicable. Excepting the Hesperioidea, the order of families generally follows that proposed by Ehrlich & Ehrlich (1961). Subfamilies are not designated (Hesperioidea excepted) and genera are listed alphabetically according to recent revisionary work. Relative abundance is not noted, as this is strongly seasonal (year-to-year variation) and is affected by climatic conditions. Single specimen records are noted. Several collectors have kindly supplied records which are so designated: (HA) Bruce Harris, (H) Richard Holland, (R) Kilian Roever, (T) Michael Toliver, (Z) Dale A. Zimmerman. William Baltosser provided the Gila Wilderness records (GW).

MEGATHYMIDAE

Agathymus aryxna (Dyar). **Grant Co.**: HM; CCC, WS (Z); T (R, T). **Hidalgo Co.**: AN (T). July, immatures in *Agave palmeri* Engelm.; adults in October.

Agathymus neuvoegeti (Edwards). **Catron Co.**: M (R). **Grant Co.**: PA; CCC, MC, ST (R). August-October, immatures in *Agave parryi* Engelm.; adults in October.

Megathymus coloradensis navajo Skinner. **Catron Co.**: GW; D, M, PT, R (R). **Grant Co.**: UGC; 7 mi. N of SC (Z); CC, IC, MC, ST, T, WS (R). April-June.

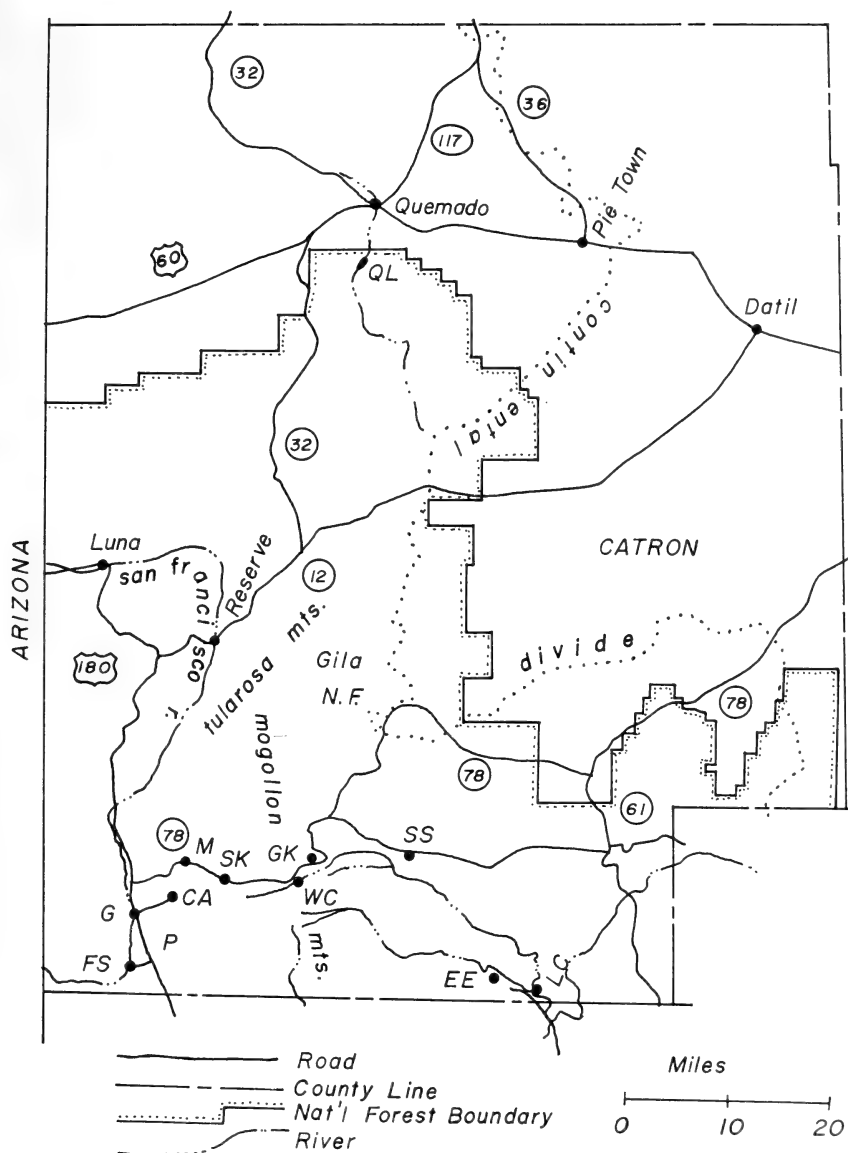


Fig. 1. Collecting sites in Catron Co., New Mexico.

HESPERIIDAE-PYRGINAE

Autochthon cellus (Boisduval & LeConte). Catron Co.: EE (Z) Grant Co. CCC. SP. July.

Celotes nessus (Edwards). Catron Co.: CA (Z). Grant Co.: RR. May.

Cogia caicus moschus (Edwards). Catron Co.: G. April. One specimen.

- C. hippalus hippalus* (Edwards). **Hidalgo Co.:** AN (T). August.
- Epargyreus clarus huachuca* (Dixon). **Catron Co.:** GW **Grant Co.:** CCC, EC, IC; SC (Z). May–July.
- Erynnis brizo burgessi* (Skinner). **Grant Co.:** ASC, CCC, EC, F, FB, IC, LS, LW. March–May, July.
- E. funeralis* (Scudder & Burgess). **Grant Co.:** BM, CCC, F, MC, SP, SR–26. April–May, August–September.
- E. icelus* (Scudder & Burgess). **Catron Co.:** SK, WC and vicinity (R). June.
- E. meridanus meridanus* Bell. **Catron Co.:** G, W of M. **Grant Co.:** FB, MC. April, August.
- E. pacuvius pacuvius* (Lintner). **Catron Co.:** GW. **Grant Co.:** CCC, LW, PA. March, May–June, August.
- E. (persius) fredericki* H. A. Freeman. **Catron Co.:** G, LN. **Grant Co.:** CCC, MC, SA, UGC. March–May, August.
- E. telemachus* Burns. **Catron Co.:** G, GW **Grant Co.:** ASC, BM, BR, CCC, EC, F, GC, IC, LGC, LW, SP. March–June.
- E. tristis tatus* (Edwards). **Catron Co.:** G, GW. **Grant Co.:** BM, MC. July–August.
- Pholisora catullus* (Fabricius). **Catron Co.:** G. **Grant Co.:** B, FH, T. August.
- Pyrgus communis* complex. *P. c. communis* and *P. c. albescens* are synchronic and sympatric in some areas. They are widespread in all life zones and are found wherever members of the Malvaceae grow. Males may be positively identified by their genitalia. Only partial records are listed below.
- P. c. albescens* Plötz. **Catron Co.:** G, LC, P, WC. **Grant Co.:** AC, BC, BM, CCC, MC, SL, SO, TC, WC. June–October.
- P. c. communis* (Grote). **Catron Co.:** WC. **Grant Co.:** EC, IC, LS, MC, UGC. May–June, August, October.
- P. scriptura* (Boisduval). **Catron Co.:** G. March. This species is bivoltine in many areas. I have not yet found the summer brood in Catron/Grant Co.
- P. xanthus* Edwards. **Catron Co.:** 3 m. E of M (H); WC area (R). April, June.
- Staphylos ceos* (Edwards). **Catron Co.:** G. **Grant Co.:** GR, RR. **Hidalgo Co.:** AN (T). April–May, July–August.
- Thorybes pylades* (Scudder). **Grant Co.:** AC, BM, CCC, F, LS, MC, TC. **Sierra Co.:** EP. May–August.
- Timochares ruptifasciatus* (Plötz). **Grant Co.:** LW (Z). One specimen on 20–ix–63.
- Zestusa dorus* (Edwards). **Grant Co.:** CCC, EC, IC. April–May.

HESPERIIDAE-HESPERIINAE

- Amblyscirtes aenus* ssp. **Catron Co.:** CA (R). **Grant Co.:** CC; CCC, GR, Mimbres Canyon (Mimbres River) (R). May–July. The southwestern race of *A. aenus*, which probably represents an undescribed subspecies, is easily confused with *A. cassus*. Both occur in Grant and Catron Co. They are genitalic distinct entities. In *aenus*, the uncus has two distinct processes on each side and the valva is relatively blunt with the distal end straight up; in *cassus*, the uncus has one distinct and finely tapered process on each side with only a suggestion of the second process, and the distal end of the valva is quite pointed and somewhat recurved. The ventral surface of the forewings exhibits considerably more orange-fulvous color in *cassus* than in *aenus*. The dorsal surface spots in *cassus* are entirely orange-fulvous while they are cream to barely fulvous in *aenus*.
- A. cassus* Edwards. **Catron Co.:** GW. **Grant Co.:** CC, CCC, SP, UGC. July–August.
- A. eos* (Edwards). **Grant Co.:** LS, MC. August.

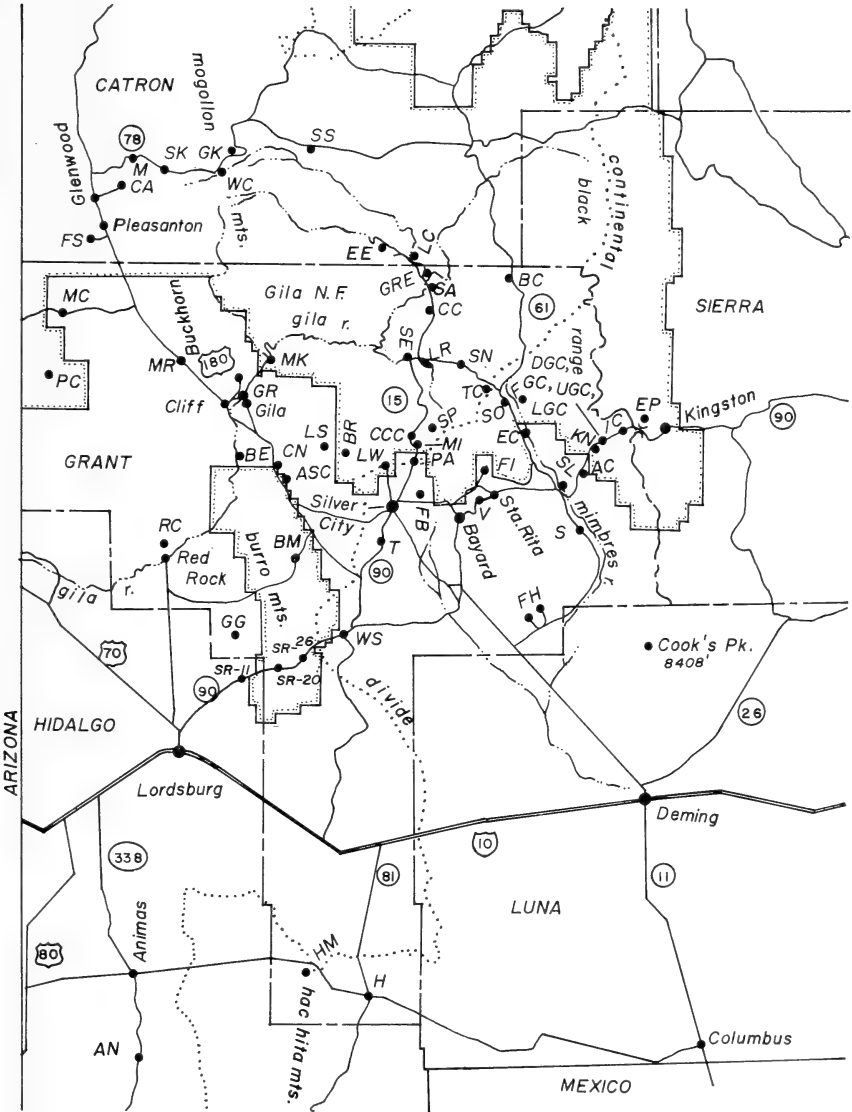


Fig. 2. Collecting sites in Grant Co. and surrounding areas, New Mexico. Note: Fig. 2 is to the same scale and uses the same legends as Fig. 1.

- A. exotera* (Herrich-Schäffer). Catron Co.: GW Grant Co.: ASC. July.
A. nereus (Edwards). Grant Co.: CCC, GRE, (R). July–August.
A. osleri (Skinner). Catron Co.: CA (R). Grant Co.: MC (R). May–June.
A. phylace (Edwards). Grant Co.: TC. July.
A. simius Edwards. Grant Co.: LS, MC, SR-26, TC. July–August.

- Atalopedes campestris* (Boisduval). **Grant Co.:** IC. May.
- Atrytonopsis deva* (Edwards). **Catron Co.:** G. **Grant Co.:** CC, CCC. April-June.
- A. lunus* (Edwards). **Grant Co.:** LS. August.
- A. pittacus* (Edwards). **Catron Co.:** G. **Grant Co.:** BR, CCC. March-June.
- A. python* (Edwards). **Grant Co.:** CC; SC (Z). June.
- A. vierecki* (Skinner). **Grant Co.:** BM, CCC, GG, LS, MC; SC (Z). May-June.
- Copaodes aurantica* (Hewitson). **Catron Co.:** GW. **Grant Co.:** BE, BM, CN, MC, PC, RR; C, SC, T (Z). April-October.
- Euphyes vestris vestris* (Boisduval). **Catron Co.:** EE. **Grant Co.:** CCC. June-July.
- The correct subspecific name to apply to Rocky Mountain *vestris* is in doubt. Coastal California *vestris* are larger and lighter in color than inland western *vestris*.
- Hesperia harpalus susanae* Miller. **Catron Co.:** GW, WC. July-August.
- H. pahaska pahaska* Leussler. **Catron Co.:** FS. **Grant Co.:** BM, LS, MR, SE, SP, V. May-June, September-October. Specimens from SW Hidalgo Co. are referable to *H. p. williamsi* Lindsay. Grant Co. specimens seem to be nominate *pahaska*.
- H. uncas uncas* Edwards. **Grant Co.:** AC, LS, MC, MR, SC, SR-26. July-September. Intergrading with *H. u. lasus* (Edwards) occurs.
- H. viridis* (Edwards). **Catron Co.:** WC **Grant Co.:** BR, CC. June-August.
- H. woodgatei* (Williams). **Catron Co.:** FS. **Grant Co.:** MR, TC. July, September-October.
- Oarisma edwardsii* (Barnes). **Grant Co.:** DGC. August.
- O. garita* (Reakirt). **Catron Co.:** WC and vicinity, LN (R). June-July.
- Ochlodes snowi* (Edwards). **Catron Co.:** GW, WC. July-August.
- Piruna pirus* (Edwards). **Catron Co.:** SK (R). **Grant Co.:** GR (R). June.
- P. polingii* (Barnes). **Catron Co.:** GW. **Grant Co.:** CCC, IC. Early July, August. Possibly bivoltine.
- Poanes taxiles taxiles* (Edwards). **Catron Co.:** GW, LC, SK. **Grant Co.:** CCC, DGC, LGC, IC, SP. **Sierra Co.:** EP. July-August.
- Polites themistocles* (Latreille). **Catron Co.:** LN, GK (R). June-July.
- Stinga morrisoni* (Edwards). **Grant Co.:** LGC. April.
- Yvretta carus* (Edwards). **Grant Co.:** MC. August.

Two species have been collected in the Peloncillo Mountains which may occur elsewhere in Hidalgo Co. or in Grant Co.: *Amblyscirtes texanae* Bell; *Hesperia pahaska williamsi* Lindsay (T). *Hylephila phyleus* (Drury) ought to be common in gardens in the Silver City area, but I know of only one record of a specimen extracted from a car radiator on 30-viii-64 (HA). The vehicle was reported to have come from the Gila Wilderness Area, which means that the specimen came from northern Grant or southern Catron Co. In August, 1970, I saw a large pyrgine-like skipper nectaring at desert willow along the banks of the Gila River south of Red Rock, Grant Co. Because of its position, it was not possible to net it. It exhibited large white hyaline spots on the forewings and appeared to be one of the following: *Polygonus leo arizonensis* (Skinner), *Codatractus arizonensis* (Skinner), *Pyrrhopyge araxes arizonae* (Godman & Salvin). The latter was quite common at the time in southern Arizona. *P. l. arizonensis* has been taken in the vicinity of Alamogordo, Otero Co. (H).

PAPILIONIDAE

- Battus philenor philenor* (Linnaeus). **Catron Co.:** GW, P. **Grant Co.:** FH, MC, SC, SO, RR. June-September. I have sighted numerous adults flying across desert roads in many areas of Grant Co.
- Papilio bairdii bairdii* Edwards. **Catron Co.:** G. A single female of typical Cali-

- fornia *bairdii* phenotype, 8-vi-66. Hubbard lists a questionable record from the Pinos Altos Mtns., Grant Co. See comments under *P. polyxenes*.
- P. crespontes crespontes* Cramer. **Grant Co.**: BM, CCC, SC, WS vicinity (Z). June-August.
- P. multicaudata* (Peale MS.) Kirby. **Catron Co.**: GW, SK; G (Z). **Grant Co.**: CCC, EC, IC, LGC, LS, SP; BM, RR (Z). **Grant-Hidalgo Co.** line on State Road 90. March, May-August.
- P. polyxenes* complex. Possibly all *polyxenes*-like specimens from the area should be referred to this species. Three specimens have been taken which in facies resemble *P. rudkini clarki* Chernock & Chernock, based upon comparison with paratypes of *clarki*. These are from **Grant Co.**: LR, 11-viii-68, a fresh male; RR, 3-vi-73, two females.
- P. polyxenes asterius* Stoll. **Grant Co.**: H, LR, LGC, LS; SC, SP (Z). May, August. The subspecific name *asterius* has been applied, but specimens from Grant Co. are rather different from eastern *asterius*.
- P. rutulus arizonensis* Edwards. **Catron Co.**: G, GW. **Grant Co.**: CCC, EC, SP. May-June.

PIERIDAE

- Appias drusilla poeyi* (Butler). **Grant Co.**: SC (Z). One specimen on 24-vi-71.
- Anthocharis sara inghami* Cunder. **Catron Co.**: CA, G, GW, LC. **Grant Co.**: ASC, CCC, GR, LGC, LW, RR, UGC; C, SC (Z). March-April.
- Colias alexandra* ssp. **Catron Co.**: GW, SK, WC. June, August. See discussion of this subspecies in Ferris (1973).
- C. eurytheme* Boisduval. **Catron Co.**: G, GW, LC, P, SK, WC. **Grant Co.**: BM, CCC, H, IC, LS, MC, RR, SP. **Hidalgo Co.**: L; 20 mi. S of H (Z). March-September.
- C. philodice eriphyle* Edwards. **Grant Co.**: C, GR, SC (Z). April, September, November.
- Colias (Zerene) cesonia* (Stoll). **Catron Co.**: GW, LC. **Grant Co.**: AC, MK, SC; 5 mi. S of C, 8 mi. W of SC (Z); CCC, IC (T). March, June-November.
- Euchloe hyantis lotta* (Beutenmüller). **Grant Co.**: CCC, GR, SP. March, May.
- Eurema mexicana* (Boisduval). **Grant Co.**: BR, CCC, CN, FB, LGC, SC, SP. **Hidalgo Co.**: L. April-October.
- E. nicippe* (Cramer). **Catron Co.**: G, P. **Grant Co.**: CCC, FH, H, LGC, MC, RR, SR-26. **Hidalgo Co.**: L. March-September. Common and widespread.
- Nathalis iole* Boisduval. **Catron Co.**: GW. **Grant Co.**: B, BM, CCC, IC, LGC, LS; 6 mi. E of SC (Z). April-September.
- Neophasia menapia menapia* (Felder & Felder). **Catron Co.**: GW; WC (Z). **Grant Co.**: CCC, SP; PA (Z). July. Associated with ponderosa pine.
- Phoebis agarithe agarithe* (Boisduval). **Catron Co.**: P. Single female on 22-viii-71.
- P. sennae eubule* (Linnaeus). **Catron Co.**: G, GW, P. **Grant Co.**: C, FH, LS, RR, SC, ST. **Hidalgo Co.**: L. August-September.
- P. sennae marcellina* (Cramer). **Grant Co.**: A, AN, UGC; BM (Z); CCC, IC (T). **Luna Co.**: CO. April, August-September.
- Pieris napi mogollon* Burdick. **Catron Co.**: GW, SK, WC. May, August.
- P. protodice protodice* (Boisduval & LeConte). **Catron Co.**: GW, LC, WC. **Grant Co.**: AC, CCC, EC, F, FB, IC, LS, MC, PC, RR, SP; LW, T, SC (Z). **Hidalgo Co.**: L. **Luna Co.**: 20 mi. S of DM (Z). March-April, form *vernalis* Edwards; June-September.
- P. rapae* (Linnaeus). **Catron Co.**: GW. **Grant Co.**: B; SC (Z). March-April, June, October.
- P. sisymbrii elivata* (Barnes & Benjamin). **Catron Co.**: CA. **Grant Co.**: CCC, EC, F, GC, GR, IC, LW, UGC; SC (Z). March-May.

RIODINIDAE

- Apodemia mormo* nr. *mejicanus* (Behr). **Catron Co.:** CA (Z). **Grant Co.:** BE, BM, LS; CCC, SC (Z). **Hidalgo Co.:** SR-11. May-June, August.
A. nais (Edwards). **Catron Co.:** GW. **Grant Co.:** CCC, MI, PA. June-July.
A. palmerii palmerii (Edwards). **Catron Co.:** FS. **Grant Co.:** GR, RR. **Hidalgo Co.:** L. **Luna Co.:** DM. June, August-September.
Calephelis nemesis nemesis (Edwards). **Grant Co.:** RR. Single fresh male on 18-vi-72.
Emesis zela cleis (Edwards). **Catron Co.:** CA, GW. May.

LYCAENIDAE

- Atlides halesus halesus* (Cramer). **Grant Co.:** AC, BM, BR, S, SR-26; 9 mi. S of C, SC (Z). **Luna Co.:** Cook's Peak summit (Z). March-April, August-September.
Brephidium exilis exilis (Boisduval). **Grant Co.:** FH, KR, RR, SP, T; MK, SC (Z). June-October.
Callophrys (Callophrys) apama apama (Edwards). **Grant Co.:** CCC. June-July.
Callophrys (Incisalia) augustinus annetteae (dos Passos). **Grant Co.:** LGC, LS; SC (Z). April-June.
C. eryphon eryphon (Boisduval). **Catron Co.:** LN, SK, WC (R). **Grant Co.:** IC (R). May-June.
Callophrys (Mitoura) siva siva (Edwards). **Catron Co.:** EE, GW. **Grant Co.:** BM, CC, CCC, FB, FI, GC, LS; SC (Z). April-July.
C. spinetorum (Hewitson). **Catron Co.:** GW, WC. **Grant Co.:** CCC, F, IC; SP (Z). May-June.
Celastrina argiolus cinerea (Edwards). **Catron Co.:** G, GW, SK, WC. **Grant Co.:** BM, CCC, IC, PC, RR, SN, SP; SC (Z). March-October.
Erora quaderna sanfordi dos Passos. **Grant Co.:** BR, CCC, LGC. February-May.
Euristrymon ontario ilavia (Beutenmüller). **Grant Co.:** BM, MC. May-June.
Everes amyntula herri (Grinnell). **Catron Co.:** EE, GW, SK. **Grant Co.:** CCC, EC, F, IC, SP; SC (Z). **Hidalgo Co.:** AN. April-May, August.
Glaucopsyche lygdamus arizonensis McDunnough. **Catron Co.:** GW. **Grant Co.:** CCC, F, SP. April-May.
Hemiargus ceraunus gyas (Edwards). **Catron Co.:** EE, G. **Grant Co.:** AC, SR-26. **Hidalgo Co.:** L. June-August.
H. isola alce (Edwards). **Catron Co.:** GW, LC. **Grant Co.:** AC, BC, BM, CCC, EC, FH, LS, MC, RR, SC, SE, T. **Hidalgo Co.:** L. **Sierra Co.:** EP. April-December.
Hypaurotis crysalus (Edwards). **Catron Co.:** GW; CA (Z). **Grant Co.:** SP. July, September.
Leptotes marina (Reakirt). **Catron Co.:** GW. **Grant Co.:** BM, FH, IC, RR, SR-20; CCC, SC (Z). **Hidalgo Co.:** L. April-September. A widely distributed species.
Lycaeides melissa nr. *pseudosamuelis* Nabokov. **Catron Co.:** GW, LC, LN. **Grant Co.:** LR, SA. August-September. Specimens are phenotypic *pseudosamuelis*.
Lycaena arota schellbachi Tilden. **Catron Co.:** SK. August.
Ministrymon ines (Edwards). **Grant Co.:** BM. One female on 24-v-75.
M. leda (Edwards). **Grant Co.:** BM, RR; CCC (Z). May-June.
Phaostroymon alcestis osleri (Dyar). **Grant Co.:** SR-20. July.
Plebejus (Icaricia) acmon texanus Goodpasture. **Catron Co.:** G, GW, LC, WC. **Grant Co.:** AC, BM, CCC, F, FH, GC, IC, LS, MC, PC, SN, SP, SR-26; C, SC (Z). **Hidalgo Co.:** L. **Sierra Co.:** EP. April-October.
P. icarioides buchholzi dos Passos. **Grant Co.:** CCC, SP. June.
Plebejus (Plebejus) saepiolus nr. *gertschi* dos Passos. **Catron Co.:** SK, WC and vicinity (R). June.

- Shijimiaeoides battoides centralis* (Barnes & McDunnough). **Grant Co.:** LGC. One fresh male on 8-viii-75. Genitalia checked to verify species. See Shields (1974) for generic discussion.
- S. rita rita* (Barnes & McDunnough). **Grant Co.:** AC, BM, SC, SR-26, T. **Hidalgo Co.:** AN, SR-13 (T). August.
- Strymon melinus franki* Field. **Catron Co.:** GW, LN. **Grant Co.:** BC, BM, CCC, F, GR, MC, RR, SC, SE, SN, T. **Hidalgo Co.:** L. April-October.

LIBYTHEIDAE

- Libytheana bachmanii* ssp. **Catron Co.:** FS. **Grant Co.:** FH, GR, MK, RR; SC (Z). March, August-September, November. In a series of specimens from this region, individuals can be assigned to both *bachmanii* (Kirtland) and *larvata* (Strecker).

NYMPHALIDAE

- Agraulis vanillae incarnata* (Riley). **Grant Co.:** SC. July-August. Scarce.
- Anaea andria andria* Scudder. **Catron Co.:** EE, G. **Grant Co.:** BM, CCC, GR, RR, SR-26; MK, SC, 6 mi. W of SC, T (Z). **Grant-Hidalgo Co.** line along State Road 90. March-April, August-September.
- Asterocampa celtis montis* (Edwards). **Catron Co.:** GW. **Grant Co.:** FH, GR. **Sierra Co.:** K. June, August-September.
- Chlosyne gabbii sabina* (Wright). **Catron Co.:** G. **Grant Co.:** CCC, IC, LGC, SA; SC (Z). March-May, July.
- C. lacinia crocale* (Edwards). **Catron Co.:** G, GW. **Grant Co.:** B, BR, CCC, FB, FH, GR, KR, MC; SC, WS (Z). **Hidalgo Co.:** L. **Sierra Co.:** K. April, June, August-September. All specimens are referred to *crocale*, although individuals may be selected from a large series which are phenotypic *adjutrix* Scudder, *nigrescens* (Cockerell) and *rufescens* (Cockerell). This region probably forms a blend-zone for the Texas *adjutrix* and the Arizona White Mtns. *crocale*.
- C. nycteis drusus* (Edwards). **Catron Co.:** SK. June.
- Cynthia annabella* Field. **Catron Co.:** GW. **Grant Co.:** CCC, V; SC, T (Z). August-October.
- C. cardui* (Linnaeus). **Catron Co.:** WC. **Grant Co.:** BM, CCC, F, LS, MC, SC, WS; 5 mi. S of C (Z). **Hidalgo Co.:** AN (T). March-September.
- C. virginensis* (Drury). **Catron Co.:** GW, SK. **Grant Co.:** BM, CCC, F, IC, LR, SP; SC (Z). **Hidalgo Co.:** AN (T). April-June, August-October.
- Danaus gilippus strigosus* (Bates). **Catron Co.:** G, GW. **Grant Co.:** CCC, FH, GR, MC, RR; 5 mi. S of C, SC (Z). **Hidalgo Co.:** L. May-September.
- D. plexippus plexippus* (Linnaeus). **Catron Co.:** GW, LC. **Grant Co.:** C, FB, FH, MC, SC, SR-26, S; BM, 10 mi. S of C, 5 mi. W of SC, T (Z). June-September.
- Dymasia dymas dymas* (Edwards). **Grant Co.:** RR. May-June, September.
- Euphydryas anicia alena* Barnes & Benjamin. **Catron Co.:** CA. **Grant Co.:** 5-6 mi. NW of SC (Z). March-April.
- Euptoieta claudia* (Cramer). **Catron Co.:** GW, P, SK, WC. **Grant Co.:** AC, BM, BR, CCC, EC, F, FH, LS, MC, RR, SP, T; SC (Z). **Hidalgo Co.:** A. April-October. Widespread and common in all life zones.
- Limenitis archippus obsoleta* Edwards. **Grant Co.:** C (Z). **Hidalgo Co.:** L. July-September.
- L. astyanax arizonensis* Edwards. **Catron Co.:** GW, LC, SK. **Grant Co.:** CCC, LGC, MI; SC (Z). June-September, November.
- L. weidemeyerii angustifascia* Perkins & Perkins. **Catron Co.:** GW, SK, WC. **Grant Co.:** BC, CCC, IC, LGC; C (Z). June-August.

- Limenitis (Adelpha) bredowii eulalia* (Doubleday). **Catron Co.:** GW. **Grant Co.:** CCC, LS, MI, SC; 6 mi. SW of T (Z). May–September, November.
- Nymphalis antiopa* (Linnaeus). **Catron Co.:** GW, WC. **Grant Co.:** B, BM, CCC, LGC; SC (Z). April–September.
- N. californica californica* (Boisduval). **Catron Co.:** GW. **Grant Co.:** CCC; SP (Z). March, June–July, October.
- N. milberti furcillata* (Say). **Catron Co.:** GW, WC. August.
- Phyciodes campestris camillus* Edwards. **Catron Co.:** G, GW, LC, WC. **Grant Co.:** H. **Hidalgo Co.:** L. August–September.
- P. mylitta arizonensis* Bauer. **Catron Co.:** LN, SK. **Grant Co.:** BM, C, CCC, DGC, SA, UGC. **Sierra Co.:** EP. March–September. See Howe (1975) for nomenclature.
- P. picta picta* Edwards. **Catron Co.:** G, LC, LN. **Grant Co.:** H, SA. **Hidalgo Co.:** L. May, August–September.
- P. tharos* (Drury). **Catron Co.:** G. **Grant Co.:** C, GR, KR. August–September. Several distinct forms are commonly collected, including *distincta* Bauer.
- Phyciodes (Anthanassa) texana texana* (Edwards). **Grant Co.:** CCC, RR. May–June.
- Poladyas minuta arachne* (Edwards). **Catron Co.:** WC. **Grant Co.:** CCC, IC, SP. June–August. See Scott (1974) for nomenclature.
- Polygonia interrogationis* (Fabricius). **Grant Co.:** SC. One specimen on 3–xi–62; 6 mi. S of C. One specimen on 10–x–63 (Z).
- P. satyrus* (Edwards). **Catron Co.:** WC. **Grant Co.:** CCC, IC, SP; SC (Z). May–August.
- P. zephyrus* (Edwards). **Catron Co.:** GW, SK, WC. **Grant Co.:** SP (Z). One specimen on 30–vi–74; May, August in Catron Co.
- Precis lavinia coenia* (Hübner). **Catron Co.:** GW. **Grant Co.:** BM, GR, KR, LGC; CCC, SC (Z). June–August, October. One male was taken at the Gila River locality on 10–viii–75 which is very close to *nigrosuffusa* (Barnes & McDunnough).
- Speyeria atlantis nausicaa* (Edwards). **Catron Co.:** GW, SK, WC. **Grant Co.:** CC, CCC, IC, SP. May–August.
- S. nokomis nitocris* (Edwards). **Catron Co.:** LC, WC. August–September.
- Texola elada perse* (Edwards). **Grant Co.:** BE, GR, RR. May–June, August.
- Thessalia alma* (Strecker). **Catron Co.:** GW, SS. **Grant Co.:** BM; 3 mi. N of WS (Z). June–July, September.
- Thessalia theona thekla* (Edwards). **Grant Co.:** BM, BR, CCC, GR, SC, WS. **Hidalgo Co.:** AN (T). May–June, August, October.
- Vanessa atalanta rubria* (Fruhstorfer). **Catron Co.:** GW. **Grant Co.:** FB; SC (Z). **Hidalgo Co.:** A. June–September.

SATYRIDAE

- Cercyonis meadlii* ssp. **Catron Co.:** M (R) **Grant Co.:** MC (R). August. Intensive searching for this species during August, 1975 in both Catron and Grant Cos. failed to produce a single specimen.
- Cercyonis oetus charon* (Edwards). **Catron Co.:** GW, WC. July–August.
- Cyllopsis pertepida dorothea* (Nabokov). **Grant Co.:** BM, BR, FB, KN, LGC, LS, SC; CCC, 3 mi. N of WS (Z). **Sierra Co.:** EP. June–September. See Miller (1974) for nomenclature and additional comments.
- Gyrocheilus patrobas tritonia* (Edwards). **Catron Co.:** M (Z). **Grant Co.:** CCC, FB, UGC. **Sierra Co.:** EP. September–October.
- Megisto rubricata cheneyorum* (R. L. Chermock). **Catron Co.:** GW. **Grant Co.:** CCC, FB, LGC; SC (Z). June–August. See Miller (1976).
- Neominois ridingsii* ssp. **Catron Co.:** SS. One fresh male on 17–vi–72.

Oeneis alberta daura (Strecker). **Catron Co.:** Crest Trail off State Road 78 (R). June.

Asterocampa leilia leilia (Edwards) and *Eurema proterpia* (Fabricius) have been taken in the Peloncillo Mountains and may stray into the Silver City area. On 23-viii-73, D. A. Zimmerman saw a specimen of *Heliconius charitonius vasquezae* Comstock & Brown at the north edge of the Western New Mexico University campus. The specimen was not captured, but Zimmerman is quite familiar with the species as he has collected it in Florida and the Neotropics.

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BIOLOGY AND TAXONOMY OF THREE GALL FORMING SPECIES OF *EPIBLEMA* (OLETHREUTIDAE)

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Epiblema Hübn. in North America comprises 39 species, mostly named over a half century ago (Brown, 1973). Natural history information is available for fewer than 10 species and consists chiefly of host and parasite records. Studies of several species received impetus during 1920–50 because of their superficial resemblance to introduced lepidopterans and their role as alternate hosts of parasites. These interests are exemplified respectively by Thompson (1928) and Bobb (1942), the latter citing related literature. As far as known, *Epiblema* feed on Compositae; the late instar larvae bore in the stems. The three species treated in this paper produce rudimentary galls.

Besides reviewing taxonomy, this paper augments natural history knowledge of *scudderianum* (Clem.) and gives new information about *desertanum* (Zell.) and *discretivanum* (Heinr.). It reports hosts, maps geographic records, describes feeding patterns and galls, outlines seasonal life histories, and integrates the literature on the genus.

Taxonomy

The following review identifies the species treated. It is abbreviated to primary citations. I examined all types.

Epiblema scudderianum (Clemens) (Fig. 1)

Hedya scudderiana Clemens (1860, p. 358) (Type in Academy of Natural Sciences of Philadelphia, illustrated by Miller (1973)).

Euryptychia saligneana Clemens (1865, p. 141) (Possible type in British Museum (Natural History) (Miller, 1973)). *Paedisca affusana* Zeller (1876, p. 307) (Lectotype designated here, "Zeller Coll. Walsingham Collection . . .; *Paedisca affusana* Z. III, 307 fig. 38 Am. Sept. Rssl . . .; Type; B. M. ♀ Genitalia slide No. 5738," British Museum (Natural History), left forewing and distal part of right forewing missing, hindwing length 8.0 mm).

Epiblema desertanum (Zeller) (Fig. 2)

Paedisca desertana Zeller (1876, p. 306) (Lectotype designated here, "Dallas, Tex. Boll; Type 14338; *Paedisca desertana* Z.; . . . Lectotype des. W. E. Miller," Museum of Comparative Zoology, ♂, forewing length 8.0 mm).



Figs. 1-3. Wings of *Epiblema*. 1, *scudderianum* ♂, Ottawa Co., Michigan, forewing 8.0 mm; 2, *desertanum* ♂, Ingham Co., Michigan, forewing 8.0 mm; 3, *discretivanum* ♀, Chatham Co., Georgia, forewing 6.5 mm.

Epiblema discretivanum (Heinrich) (Fig. 3)

Eucosma discretivana Heinrich (1921, p. 823) (Type No. 23743, National Museum of Natural History).

Forewing patterns of *scudderianum* (Fig. 1) and *desertanum* (Fig. 2) scarcely vary while that of *discretivanum* (Fig. 3) varies without regard to sex in degree of shading, particularly in basal and mid-dorsal areas. Size of adults is shown by the following forewing length ranges: *scudderianum*, 7.0-10.5 mm (136 examples not sexed); *desertanum* 7.0-8.5 mm (25); and *discretivanum*, 5.5-7.5 mm (37). Male genitalia are illustrated by Heinrich (1923) and female genitalia and wings by Brown (1973).

Hosts

Except as noted, host records refer to identified adults that developed naturally on the indicated plant species. Plant specimens were diagnosed or verified by E. C. Leonard, National Herbarium; J. H. Beaman, Michigan State University; and Harmon Runnels, Ohio Agricultural Research and Development Center.

Hosts of *scudderianum* in decreasing order of observation frequency were the Canada goldenrod complex, *Solidago altissima* L.-*canadensis* L.; tall goldenrod, *S. gigantea* Ait.; early blooming goldenrod, *S. juncea* Ait.; elm leaved goldenrod, *S. ulmifolia* Muhl.; and prairie goldenrod, *S. nemoralis* Ait. I reared moths from an unidentified host in Florida which was likely camphor weed, *Heterotheca subaxillaris* (Lam.) Britt. & Rusby, a host noted on museum specimens from Florida and Texas. I observed typical galls on *Aster ericoides* L. in northern Ohio but did not succeed in rearing adults.

I found *desertanum* only on the grass leaved goldenrod, *Solidago*

graminifolia (L.) Salisb. This goldenrod often occurred on the same sites as one or more of those above; both *scudderianum* and *desertanum* sometimes occurred at such sites. *Epiblema discretivanum* occurred mostly on groundsel-tree, *Baccharis halimifolia* L., but I reared adults also from narrow leaved groundsel, *B. angustifolia* Michx., and *B. glomeruliflora* Pers.

Geographic Distribution

Three types of locality records appear in Fig. 4: (1) where I reared adults that were subsequently identified, (2) where museum specimens that I verified were collected (museums included National Museum of Natural History, Canadian National Collection, and American Museum of Natural History), and (3) where I observed galls only. The map shows gall-only records where there were gaps in the first two types of records. Only one map symbol appears where two or more for the same species were close enough to overlap.

Records for *scudderianum* occur from Maine south to Florida and west to North Dakota and Texas. Those for *desertanum* occur through practically the same area while those for *discretivanum* are confined to the coastal plain from Georgia and Florida to Texas (Fig. 4).

Larval Feeding Pattern

Between hatching and entering stems, *scudderianum* larvae evidently fed at host tips. This was inferred from several series of observations typified by the following example. In mid-July, I examined 25 *Solidago altissima-canadensis* plants with incipient galls in a field in southern Michigan. The tip of every plant had been mined by a small insect no longer present. In the same field on the same date, I examined another 25 plants that had mined tips. Of this group, 16 had incipient *scudderianum* galls; larvae on the remaining nine plants probably did not survive to start galls. Limited observations suggest similar pre-gall feeding by *desertanum*. I did not observe *discretivanum* for pre-gall feeding.

A total of 85 incipient *scudderianum* galls which I examined in June and July in Ohio, Maryland, and Michigan had one and usually two small openings between the gall chamber and outside. One opening was gradually enlarged throughout the summer whereas the other usually was not. I assume the latter to be the passage by which the larva entered the stem. It was often located just above a leaf attachment. The enlarged opening served as a hatch through which the larva periodically ejected debris, mostly frass. The debris hatch was covered with silk when not in use. Some entry passages may have been converted to debris

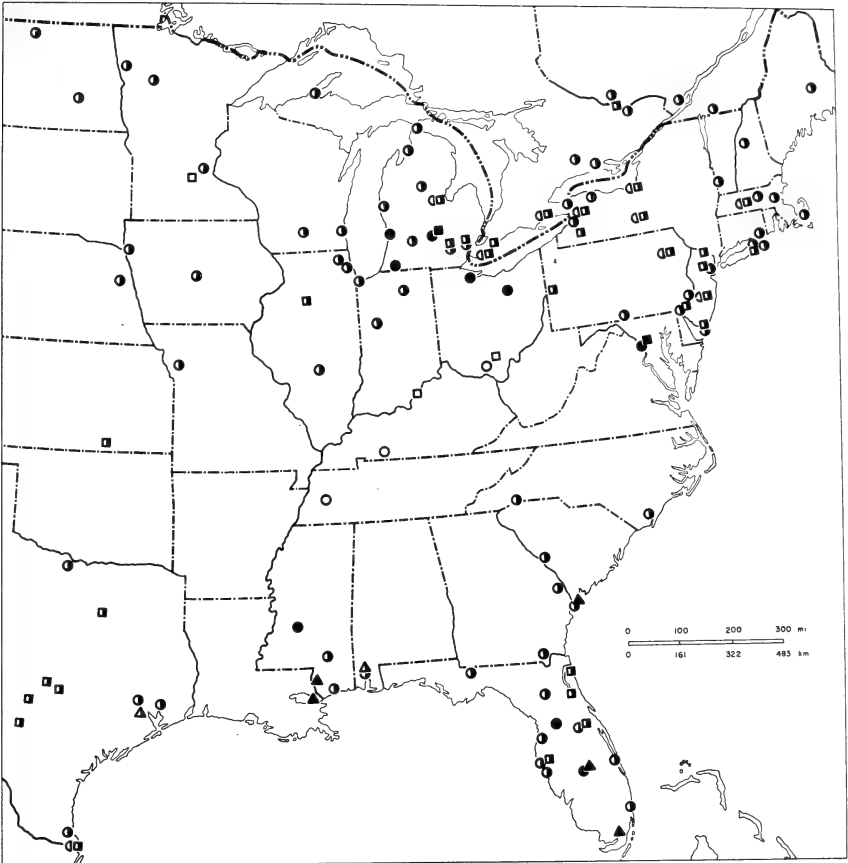


Fig. 4. Distribution of records for *Epiblema scudderianum* (circles), *desertanum* (squares), and *discretivanum* (triangles). Solid symbols signify reared adults; half open symbols, museum specimens; full-open, galls.

hatches. I observed ejection of debris from galls brought indoors; frass intercepted by leaves beneath galls is a common sight in the field. Kellicott (1878) also reported ejection of debris by *scudderianum*. Debris hatches were usually located in the lower half of *scudderianum* galls. After larvae became full-grown and ceased to feed and excrete, they permanently sealed debris hatches with a dark brown noncellular material probably of larval origin. Such plugs were closely fitted and when removed looked somewhat like train wheels.

Debris hatches and plugs occurred in *desertanum* and *discretivanum* galls but were located in the upper half of galls. No entry passages

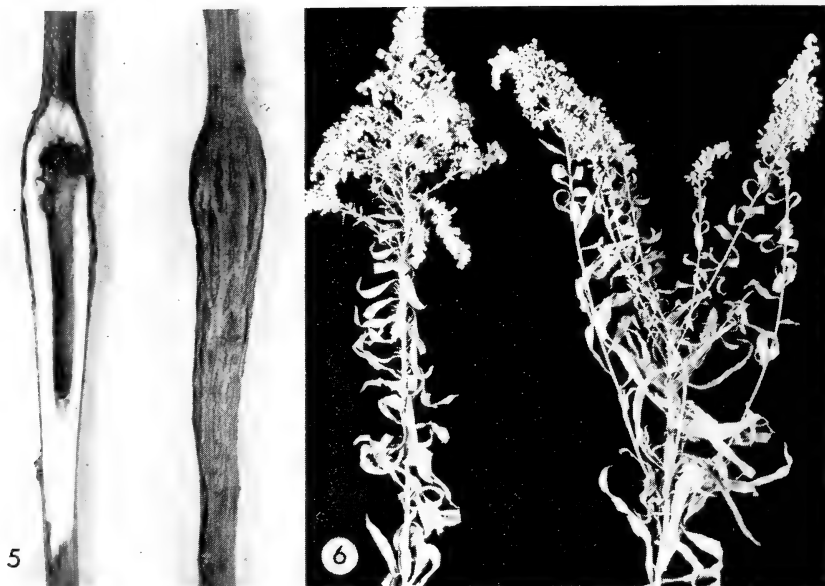


Fig. 5. Galls of *Epiblema discretivanum* on *Baccharis halimifolia*. Left, sectioned to show larval tunnel and moth exit. Right, intact.



Fig. 6. Upper stem of flowering *Solidago altissima-canadensis*. Left, normal plant. Right, branched plant infested by *Epiblema scudderianum*. Gall is visible near center of the segment of stem shown.

separate from debris hatches were identified in either species, the entry passages probably having been converted to debris hatches.

Apparently due to host reaction, *scudderianum* and *desertanum* galls occasionally ruptured, exposing the larval feeding chamber. Counts in Maryland in mid-July showed 7 of 25 *scudderianum* and 9 of 48 *desertanum* galls in various stages of rupture. Several larvae were continuing their feeding in adjacent parts of the same stems.

Stem tunnels of larvae that pupated ranged in length as follows: *scudderianum*, 3.2–5.0 cm (16 observations); *desertanum*, 4.5–4.7 cm (2); and *discretivanum*, 2.1–3.3 cm (24).

Mature larvae excavated moth exit tunnels in the upper half of galls, leaving only a thin layer of plant tissue. They spun silken funnels that guided the emerging insect into the exit. Moth exits were completed by all three species before winter. The gall of *discretivanum* (Fig. 5) is similar in appearance and gross structure to the other two galls; that of *scudderianum* has been illustrated often and is shown together with *desertanum* galls by Miller (1963).

Infestation by *scudderianum* was often accompanied by branching of host plants late in the summer (Fig. 6).

Seasonal History

Scudderianum flew in May and June in northern localities. At a light near an old field in southern Michigan, I caught 30 moths between May 25 and June 21 during two years of observations. In northern Ohio during one year of observation, 6 moths emerged within the above dates from galls held in an outdoor insectary. In Maryland during one year of observation, 4 moths emerged between April 30 and May 12 from galls in an outdoor insectary. In studying galls of *Gnorimoschema gallaesolidaginis* (Riley) (Miller, 1963), I obtained one moth of *Epiblema scudderianum* during the above periods.

I made one observation concerning the flight period of *desertanum*: on June 26 in Maryland, 13 galls had protruding empty pupal cases and two had live pupae. I made no comparable observations on *discretivanum*.

The earliest dates I observed incipient *scudderianum* galls were June 20 in Maryland and June 24 in northern Ohio; *desertanum* galls, July 19 in Maryland. All three species overwinter in galls as mature larvae.

The earliest dates I observed *scudderianum* pupae were April 11 in Maryland, May 7 in northern Ohio, and May 22 in southern Michigan; *desertanum* pupae, May 24 in southern Michigan.

DISCUSSION AND CONCLUSIONS

Type examination and fixation confirms and formalizes identities and synonymies of the three species. The synonyms were proposed by Fernald (1882) as well as Heinrich (1923); it is uncertain whether Fernald saw all types but certain that Heinrich did not. Adults of the three species are recognizable from forewing pattern despite the variability in *discretivanum*. Larvae of some *Epiblema* are characterized by MacKay (1959) and pupae of two are included in Mosher's (1916) classification. Eggs of *Epiblema strenuanum* (Wlkr.) *E. carolinanum* (Wlshm.), and *E. otiosanum* (Clem.) are known (Peterson, 1965; Thompson, 1928; Decker, 1932).

Scudderianum, associated with four genera of hosts, has more known hosts than any North American *Epiblema*. It has often been reported from the Canada goldenrod complex. The five host species reported here, representing two genera, appear to be new records. Ellis (1925) listed *Bidens frondosa* as a frequent host, and two other genera observed once by him as hosts, referring to *scudderianum* as the bidens borer. One

wonders if he confused *scudderianum* with the true bidens borer, *otiosanum*, but he stated correctly that his insect was univoltine whereas *otiosanum* is multivoltine (Decker, 1932). *Desertanum* has only one known host in the North; its host or hosts in the South, where *Solidago graminifolia* does not occur (Fernald, 1950), are unknown. Thus far, *discretivanum* is known only from the three species of *Baccharis* listed in this paper. Heinrich (1921) said it formed a gall on "wild myrtle" which Bottimer (1926) identified as *B. halimifolia*.

All three *Epiblema* studied appear confined to eastern North America. Distributions of *scudderianum* and *discretivanum* and their most frequent hosts closely coincide; the same is true for *desertanum* in the North. *Discretivanum* likely occurs in the West Indies and other Caribbean areas because its hosts are there (Small, 1933).

Riley (1883) stated that *scudderianum*, in one of several alternate feeding patterns, fed first on tips and later formed galls. Kellicott (1882) confirmed gall forming but not tip feeding. Riley mixed species and even genera of goldenrod-feeding olethreutids in his observations. Whether he observed true *scudderianum* tip feeding is uncertain. Pre-gall tip mining by *scudderianum* and *desertanum* may represent an early feeding mode characteristic of other olethreutid larvae (MacKay, 1963). Similar feeding has been reported in *otiosanum* (Decker, 1932), *carolinanum* (Thompson, 1928) and *tripartitanum* (Zell.) (Bottimer, 1926).

Early debate about whether *scudderianum* induced gall formation arose in part by *scudderianum* moths apparently emerging from *Gnorimoschema* galls (Kellicott, 1882). Judd (1951) as well as I observed the same phenomenon. Old galls of these two gall makers can be confused. On the other hand, *scudderianum* larvae whose galls rupture might find their way into *Gnorimoschema* galls just as some *otiosanum* larvae wander to new sites before overwintering (Decker, 1932).

In contrast to linear stem boring, *scudderianum*, *desertanum* and *discretivanum* concentrate their feeding within a short length of stem. Maximum stem swelling seems to be associated with the point of maximum internal feeding. After *scudderianum* larvae form their chambers, cambial activity is greatly accelerated. Tissues internal to the cambium are grazed (Blum, 1953). Ejection of debris is essential where feeding is intensified in a small area. Branch proliferation due to *scudderianum* has counterparts in hosts of *strenuanum* (Crawford, 1933) and *carolinanum* (Thompson, 1928).

North American *Epiblema* with known biologies overwinter as mature larvae. *Scudderianum* and *desertanum* are apparently univoltine in the North. In Ontario over several years, Brodie (1909) observed *scudder-*

ianum moths flying between June 12 and July 1, two weeks later than I observed in southern Michigan. Moth flight, gall formation, and pupation appear to be earlier in Maryland than in the Midwest.

Galls of all three species observed in this study persist for a year or longer after their makers leave and many are used as homes by other arthropods (Miller, 1966).

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A POSSIBLE SOURCE OF MORTALITY IN *PAPILIO TROILUS* (PAPILIONIDAE) POPULATIONS IN EASTERN TEXAS

While collecting *Papilio troilus* (L.) eggs in the vicinity of the Hardin town dump in Hardin Co., Texas, on 21 March 1972, several trails of leaf-cutter worker ants were observed carrying pieces of leaves to their nests presumably for culture medium for their fungal "gardens" (Creighton, 1950, Bull. Mus. Comp. Zool. Harvard Univ. 104: 325-329). These ants were kindly determined by Dr. Wm. L. Brown, Jr. to be *Atta texana* (Buckley). One of the small shrubs which was rapidly being defoliated of its succulent spring growth of leaves was *Sassafras albidum* (Nutt.), which was also the main plant species being utilized for oviposition by *P. troilus*. While looking at one particular sassafras plant I was able to rescue a *troilus* egg on an excised leaf section that was actually being carted off down the stem by an ant and three more eggs on leaves certainly destined for the same outcome. The probable fate would have been death, but the proximate source of mortality could have been any of several, including desiccation, predation by ants, or fungal attack of either eggs or larvae. These eggs and the resulting larvae were instead reared through to *P. troilus* adults on *Sassafras albidum* in Ithaca, New York. Specimens of *P. troilus* and *Atta texana* from these Hardin County populations have been deposited in The Cornell University Collection: Lot 1023, subplot 13b.

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MIGRATION OF BUTTERFLIES ALONG THE GULF COAST OF
NORTHERN FLORIDA

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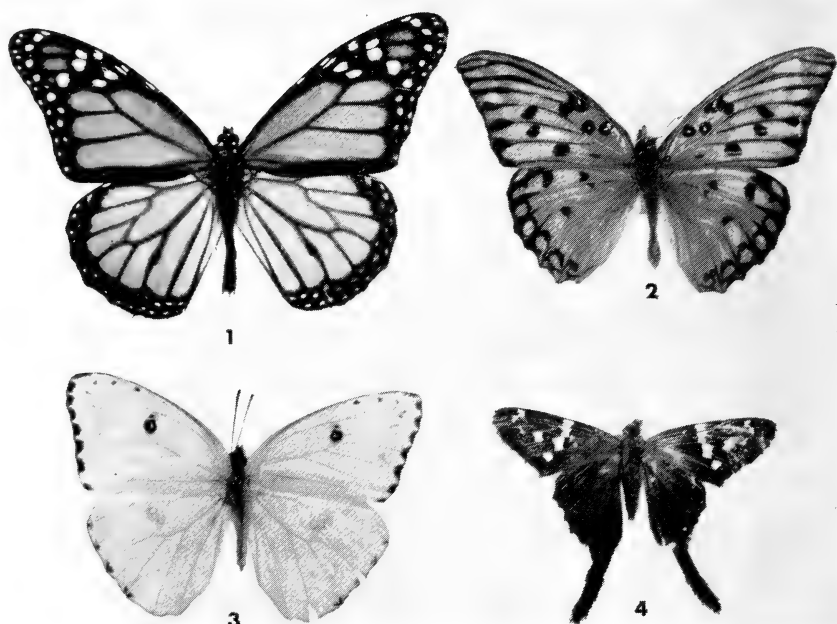
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For the past five years (1970-75) we have been making an intensive study of the Gulf Coast migrations of the monarch butterfly (*Danaus plexippus plexippus* [L.]) with special reference to the main migration route along the coast of northern Florida. Most of our observations and alar tagging have been conducted in the vicinity of Apalachee Bay at St. Marks Lighthouse, Wakulla Beach, Shell Point, and Live Oak Point. Although the migrants pass through this area during the latter part of October, the peak period of abundance has been consistently between October 20-25. Prior to October 20 and after October 25, relatively few migrants were recorded, although stragglers continued to pass through the area as late as mid-January. On one or two days during this brief period, a peak movement occurs involving countless thousands of individuals. The results of this study, as they pertain specifically to the monarch butterfly, will be presented at a later date.

In the present paper we report that along with the monarchs were three other species of migrating Lepidoptera, namely, *Agraulis vanillae* (L.), *Urbanus proteus* (L.) and *Phoebis sennae eubule* (L.). Each of these species occurred in great numbers during the migrating period, and, during the free-flight period (non-feeding) they all moved in a definite westerly direction, following the coastline.

The cloudless Sulphur, *Phoebis sennae eubule*, a well documented migratory species (Williams, 1930, 1958), was observed migrating northward from the open ocean toward land at Live Oak Point. On reaching land, these migrants altered direction abruptly and followed a west direction. This band of migrants, extending 200' across, flew in an endless procession within a few centimeters of the water and, on land, close to the vegetation; only an occasional specimen moved toward the flowering goldenrod to feed. An average of 480 migrants per minute passed the observation point.

The gulf fritillary, *Agraulis vanillae*, has been reported as a migrant by many authors, as listed by Williams (1930, 1958). As this species moved along the coast, they fed upon the nectar of *Baccharis halimifolia* and *Solidago puberula*. An average of 32 specimens was recorded feeding upon the nectar of each of five *B. halimifolia* bushes, a plant that grows



Figs. 1-4. Gulf Coast migrants. 1, *Danaus p. plexippus*; 2, *Agraulis vanillae*; 3, *Phoebis sennae eubule*; 4, *Urbanus proteus*. Many specimens collected were travel-worn, indicating long flights.

extensively along the sand dune area of the coast and flowers at the time of the peak migration. On being disturbed, these migrants continued westward, following the coastline. The reports of flight directions, as given by Williams and others for this species, are rather confusing since, depending upon the geographic location of the observation, flights might be recorded in every compass direction. This is due, in part, to the southerly flight of migrants, aberrant flights due to topographical influences, motion toward flowering plants, and the presence of non-migrating nomadic breeding populations. We believe that the movement of these migrants is southerly, as mentioned by Harris (1972), but, like the monarch butterfly, has a westward direction on reaching the coastal area.

The long-tailed skipper, *Urbanus proteus*, has been reported by Scudder (1889) as occurring in numbers, but with no record of flight directions. Williams (1958) records sight observations of a migration to the north in the spring and to the south in the autumn in Florida, but the actual locality in Florida where the observations were made is not given.

Although general migration patterns for a given geographic area can be indicated by careful observations for a given geographic area, it is necessary to have accurately recorded observations for many localities to establish a definite flight path. The most definitive method is that of following a marked individual of a moving population by means of individual designations, as shown on the cover of *Insektenmigrationem* (Annual Report for 1974). In this manner release-recapture lines can be accurately plotted over long distances. For small species, such as *Urbanus proteus*, one must rely on observations, such as contained in the present paper, and reports from other, preferably widely distributed, localities.

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OCCURRENCE OF *LEPTOTES CASSIUS THEONUS* (LYCAENIDAE) IN GEORGIA

On 29-30 September 1974, I collected 20 males and 6 females of *Leptotes cassius theonus* (Lucas) on Skidaway Island, Chatham Co., Georgia. This species was not mentioned by Harris (1972, Butterflies of Georgia. University of Oklahoma Press) and has apparently not heretofore been recorded from Georgia. All the specimens were taken from what appeared to be a well-established colony situated along a short stretch of dirt road just northwest of Priest Landing on the Wilmington River side of the island. Although it was quite abundant in this particular locality, *L. c. theonus* was nearly overlooked because of its superficial resemblance to *Hemiargus ceraunus antibubastus* Hübner, which was equally abundant. It appears likely that careful exploration of Georgia's coastal islands will reveal the existence of additional *L. c. theonus* colonies.

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NEW HESPERIIDAE RECORDS FOR MEXICO

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During the past year I have been making concentrated efforts to complete a study that I have been making on the HesperIIDae of Mexico. Through research conducted in the American Museum of Natural History, collecting widely over Mexico and determining specimens for various museums and collectors I have found 12 new species and 33 new records of hesperiids from Mexico during that period of time. In this article I will deal only with the new records and in a separate article the new species.

PYRGINAE

Tarsoctenus praecia (Hewitson, 1857)

Type locality. Santarem, Brazil.

Distribution. Lower Amazon River, Para, Brazil. There is a specimen in the American Museum of Natural History labelled, Mexico.

Drephalys dumeril (Latreille, 1824)

Type locality. Uncertain.

Distribution. The British Museum contains specimens of this species from the following locations: Panama, Venezuela, Br. Guiana, Surinam, Fr. Guiana, Ecuador (La Chima) and Brazil (Bahia, Maranham, Joinville). I have seven males of this species in my collection from Candelaria Loxicha, Oaxaca, Mexico, collected during July, August, September and October, 1968-71, all obtained from E. C. Welling.

Drephalys oria Evans, 1952

Type locality. Honduras.

Distribution. There are two males and a female from Honduras in the British Museum. There is a male in the American Museum of Natural History from Rancho San Carlos, Oaxaca, Mexico, collected March 12, 1969 by Peter Hubbell, and there is a male in my collection with the same data.

Aguna aurunce (Hewitson, 1867)

Type locality. Amazons.

Distribution. The British Museum contains specimens of this species from the following locations: Guatemala, Nicaragua, Panama, Colombia, Venezuela, Trinidad, Br. Guiana, Fr. Guiana, Peru (Tarapote), Upper Amazons (Teffe, Itaituba, Obidos) and Para, Brazil. I have a male in my collection from Tenosique, Tabasco, Mexico, August 24, 1962, collected by E. C. Welling.

Zestusa staudingeri (Mabille, 1888)

Type locality. Guatemala.

Distribution. There are no specimens of this species in the British Museum or

American Museum of Natural History. I have 21 specimens in my collection from Rancho Belen, 20 km south of San Christobal, Chiapas, Mexico, collected during March by Robert Wind.

Ridens philia Evans, 1952

Type locality. Colombia, Cauca, Juntas: M. de Mathan: end 1897-8.

Distribution. Colombia (Cauca, R. Dagua). I have 21 males and three females in my collection from Sta. Rosa, Comitan, Chiapas and Candelaria Loxicha, Oaxaca, Mexico, collected by E. C. Welling and T. Escalante during March, August, September and October, 1965-69.

Astrartes fulgor Hayward, 1938

Type locality. Argentina.

Distribution. The British Museum has one male with no locality data. I have in my collection two males and a female from Rancho San Carlos, Oaxaca, Mexico, August 1968. I have examined two males of this species from Campeche, Campeche, Mexico, November 15, 1967, collected by H. L. King.

Astrartes tucuti Williams, 1927

Type locality. Panama.

Distribution. Guatemala, Nicaragua, Costa Rica, Colombia, Peru (Chanchamayo, Ucayali), Bolivia and Brazil. I have a male from Tenosique, Tabasco, Mexico, September 13, 1962, collected by E. C. Welling, and a male from Rancho Dos Amatos, Veracruz, Mexico, August 1969, collected by Peter Hubbell.

Astrartes samson Evans, 1952

Type locality. Colombia.

Distribution. Honduras, Nicaragua, Costa Rica, Panama, Colombia, Venezuela, Br. Guiana, Fr. Guiana, Ecuador (Paramba), Peru (Inambari, Huancabamba), Bolivia (Reyes) and Amazons (St. Paulo d'Olivencia to Para). There is a male in the American Museum of Natural History from Presidio, Veracruz, Mexico, September 1940. I have two males in my collection from Muste, Chiapas, Mexico, August and September, 1968, collected by E. C. Welling.

Calliades zeutus (Moschler, 1878)

Type locality. Colombia.

Distribution. Panama, Br. Guiana, Upper Amazons (Iquitos) and Bolivia (Buena-vista). There is a male in my collection and one in the collection of E. C. Welling from X-Can, Quintana Roo, Mexico, June 25, 1967, collected by E. C. Welling.

Thorybes albosuffusa Freeman, 1943

Type locality. Fort Davis, Texas.

Distribution. This species is found over the Big Bend section of Texas. I have a female from 1 mile south of Cedritos, Coahuila, Mexico, June 23, 1957, and there is a specimen in the American Museum of Natural History from Colima, Mexico.

Bunglotis erythus (Cramer, 1775)

Type locality. Surinam.

Distribution. Honduras, Nicaragua, Colombia, Fr. Guiana, Br. Guiana and Brazil

(Para, Maranhão). I have examined a specimen from E. C. Welling that he collected at X-Can, Quintana Roo, Mexico, July 10, 1967.

Bungalotis astylos (Cramer, 1780)

Type locality. Surinam.

Distribution. Honduras, Costa Rica, Panama, Colombia, Venezuela, Trinidad, Br. Guiana, Fr. Guiana, Ecuador, Peru (Amazones, Carabaya, Chanchamayo, Rentema Falls), Upper Amazons (Ega) and Brazil (Para, Manaus, Matto Grosso, Rio, Petropolis). There are two males in the American Museum of Natural History from Presidio, Veracruz, Mexico, July 1939 and July 1941 (C. C. Hoffman).

Dyscophellus ramon Evans, 1952

Type locality. Bugaba, Panama.

Distribution. Honduras, Panama and "Peru." There is a female in the American Museum of Natural History from Presidio, Veracruz, Mexico, July 1941 (C. C. Hoffman).

Nascus broteas (Cramer, 1780)

Type locality. Surinam.

Distribution. Panama, Colombia, Venezuela, Trinidad, Fr. Guiana, Ecuador (La Chima, Paramba), Peru (Amazons), Upper Amazons (Ega, St. Paulo d'Olivencia), Brazil (Para, Espirito Santo) and Paraguay. I have a specimen from Tenosique, Tabasco, Mexico, August 24, 1962, collected by E. C. Welling.

Gindanes brontinus Godman & Salvin, 1895

Type locality. Nicaragua.

Distribution. Nicaragua. E. C. Welling collected two males of this species at Piste, Yucatan, Mexico, July. I have one specimen and he has the other.

Pythonides assecla Mabille, 1883

Type locality. "E. Brazil."

Distribution. Honduras, Nicaragua, Colombia, Br. Guiana, Fr. Guiana, Upper Amazon, Peru (Chanchamayo, Tarapote). In material received from E. C. Welling for determination, there were three females of this species from Mexico, two from Tenosique, Tabasco, August, and September 1962 and one from X-Can, Quintana Roo, July 2, 1965.

Ebrietas livius (Mabille, 1897)

Type locality. Bolivia.

Distribution. Ecuador (Loja, Rio Numbala), Peru (La Merced, Rio Tabaconas), Bolivia (Yungas) and Bahia. There is a specimen in my collection from Tenosique, Tabasco, Mexico, September 17, 1962, collected by E. C. Welling.

Pyrgus oileus orcus (Stoll, 1780)

Type locality. Surinam.

Distribution. Common from Costa Rica to South America. There are three males of this apparent subspecies from Tapachula, Chiapas, Mexico, August 21, 1949 (E. C. Smyth) in the Los Angeles County Museum.

HESPERIINAE

Synapte puma Evans, 1955

Type locality. Balboa, Panama.

Distribution. Panama. I have in my collection 19 males and two females of this species from Candelaria Loxicha, Oaxaca, Mexico, collected from March to October, 1968-69 (E. C. Welling).

Thargella caura (Plotz, 1882)

Type locality. Surinam.

Distribution. Nicaragua, Costa Rica, Venezuela, Trinidad, Br. Guiana, Fr. Guiana, Bolivia (Santa Cruz), Amazons (Nauta to Para) and Bahia. In specimens received for identification from E. C. Welling there was a male of this species from Tenosique, Tabasco, Mexico, August 12, 1962, in poor condition, and I have a female from Orizaba, Veracruz, Mexico, May 1907 (C. C. Hoffman) which belongs to the American Museum of Natural History.

Lerema lumina (Herrich-Schaffer, 1869)

Type locality. Uncertain.

Distribution. Guatamala, Costa Rica, Panama and Colombia. I have three males of this species in my collection collected by Robert Wind at San Carlos, Chiapas, Mexico, July 2, 1969.

Onophas columbaria (Herrich-Schaffer, 1870)

Type locality. Brazil.

Distribution. Panama, Colombia, Trinidad, Br. Guiana, Surinam, Fr. Guiana, Ecuador (La Chima, Paramba), Bolivia (Buenavista), Amazons (Teffe-Para) and Bahia. I examined a female specimen of this species collected by H. L. King at Kabah Ruins, Yucatan, Mexico, November 17, 1967.

Turesis theste Godman, 1901

Type locality. Costa Rica.

Distribution. Apparently very rare as the British Museum has only the type, and there are no specimens in the American Museum of Natural History. E. C. Welling sent me two males of this species for determination. He collected them at Tenosique, Tabasco, Mexico, August 17, 1962.

Vertica grandipuncta (Mabille, 1883)

Type locality. Para, Brazil.

Distribution. Br. Guiana, Ecuador (Ambato), Upper Amazons (Pebas, Tonantins, Santarem, Tapajos), Brazil (Para). I received two males of this species from E. C. Welling for determination. They were collected at Tenosique, Tabasco, Mexico, August 24 and 27, 1962.

Talides alternata Bell, 1941

Type locality. Santa Catharina.

Distribution. Guatemala, Costa Rica, Colombia, Venezuela, Surinam, Ecuador (Balzapamba), Peru (Chanchamayo, Chiriamayo), Para and Novo Friborgo. I have in my collection three males and two females of this species collected at

Candelaria Loxicha, Oaxaca, Mexico, during August and October, 1968-69, by E. C. Welling.

Telles arcalaus (Stoll, 1782)

Type locality. Surinam.

Distribution. Honduras, Panama, Colombia, Venezuela, Trinidad, Br. Guiana, Fr. Guiana, Peru (Rio Colorado) and Amazons (Para, St. Paulo d'Olivencia). There is a male specimen of this species in the American Museum of Natural History labelled "Ochls north Mexico," with no other data.

Carystoides orbius Godman, 1901

Type locality. Nicaragua.

Distribution. Nicaragua, Trinidad, Br. Guiana, Fr. Guiana, Surinam, Ecuador (Canalos, Rio Bobonaza), Upper Amazons and Para. In specimens received from E. C. Welling there was a male of this species collected at Tenosique, Tabasco, Mexico, September 4, 1962.

Mellana balsa freemani Steinhauser, 1974

Type locality. Santa Tecla, El Salvador.

Distribution. Santa Tecla, El Salvador, June, July and October. Sayaxche, El Peten, Guatemala, August 10, 1963 (E. C. Welling). I have in my collection four males from Candelaria Loxicha, Oaxaca, Mexico, July and August, 1969 and 1971 (E. C. Welling).

Mellana tecla Steinhauser, 1974

Type locality. Santa Tecla, El Salvador.

Distribution. Santa Tecla, Tamanique, El Salvador. I have in my collection 18 males of this species from Muste, Chiapas, Mexico, July 1968 (E. C. Welling) and five males from Candelaria Loxicha, Oaxaca, Mexico, July and August, 1969 and 1971 (E. C. Welling).

Panoquina panoquinoides (Skinner, 1891)

Type locality. Florida.

Distribution. Florida, Texas, Cayman Island, Tobago and Pernambuco. I have a male and a female of this species in my collection from Progreso, Yucatan, Mexico, October 6, 1971 (E. C. Welling).

Xeniades pteris Godman, 1900

Type locality. Panama.

Distribution. Costa Rica, Panama, Colombia (St. Marta) and Venezuela. I have a male and female of this species in my collection from Muste, Chiapas, Mexico, collected October 22, 1968, by E. C. Welling.

Saliana hewitsoni Riley, 1926

Type locality. Upper Amazons.

Distribution. Panama, Colombia, Ecuador (Paramba, La Chima, Zamora), Peru (Moyabamba), Bolivia (Reyes, Buenavista) and Amazons (Nauta, Para). Dr. W. W. McGuire brought a female specimen of this species here for me to determine

which he had received from Peter Hubbell. The specimen was collected at Catemaco, Veracruz, Mexico, November 15, 1973 by Sr. Abraham Ramirez.

ACKNOWLEDGMENT

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GENERAL NOTES

RANGE EXTENSIONS OF
CALLOPHRYS FOTIS, *C. POLIOS*, *COLIAS ALEXANDRA* AND
EREBIA CALLIAS (LYCAENIDAE, PIERIDAE AND SATYRIDAE)

Until 1971, *Callophrys* (*Incisalia*) *fotis schryveri* (Cross) was known only from Colorado and southern Wyoming (Ferris & Stanford, J. Lepid. Soc. 24: 256-266). In 1971 and 1972, it was collected in numbers by S. Kohler in the vicinity of Missoula, Missoula Co., Montana. Voucher specimens are deposited in the collection of S. Kohler and the author.

Ferris & Fisher (1973, J. Lepid. Soc. 27: 112-118) discussed the distribution of *Callophrys* (*Incisalia*) *polios* (Cook & Watson) in North America. At that time, *polios* was unknown from the Great Plains region. It was recorded from eastern Minnesota and Wisconsin, and northeastern Illinois. Eastern limits for the subspecies *obscurus* Ferris & Fisher included Missoula Co., Montana; the Black Hills, South Dakota; Albany Co., Wyoming; and south along the Colorado Front Range. In May 1973, T. McCabe collected *C. polios obscurus* in the Killdeer Mts., Dunn Co., North Dakota, a locality several hundred miles north and east of the nearest known locality of this subspecies. Voucher specimens are deposited in the collection of T. McCabe and the author.

In his revision of the *Colias alexandra* complex, Ferris (1973, J. Lepid. Soc. 27: 57-73) listed no records south of the United States-Mexico border. *Colias alexandra harfordii* H. Edwards has now been collected at several localities in Baja California (state) in the Sierra San Pedro Martir (Holland, 1972, J. Res. Lepid. 11: 147-160; H. Real, *in litt.*).

Since my paper on *Erebia callias* Edwards appeared (Ferris, 1974, J. Lepid. Soc. 28: 230-236), a number of new Colorado records for this insect have been sent to me by R. E. Stanford and D. Cowper from the following counties: Boulder, Gilpin, Gunnison, Ouray, Pitkin, Rio Grande and San Juan.

ACKNOWLEDGMENTS

I wish to thank the following for providing distribution records: D. Cowper, J. D. Eff, R. Holland, S. Kohler, T. L. McCabe, H. G. Real and R. E. Stanford.

This note is published with the approval of the Director, Wyoming Agricultural Experiment Station, as Journal Article JA 722.

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AMBLYSCHIRTES BELLI (HESPERIIDAE): A NEW RECORD FOR KENTUCKY

On July 26, 1969, between 1500 and 1600 I collected a single *Amblyscirtes belli* Freeman (♀) that was resting on a leaf in a wooded area of Chickasaw Park in Louisville, Jefferson Co., Kentucky. Determination was tentatively made by C. V. Covell, Jr. of the University of Louisville and confirmed by Mr. H. A. Freeman of Garland, Texas. This species has not been reported for Kentucky (Covell, 1974, J. Lepid. Soc. 28: 253-256), the nearest known record being in Pope Co., Illinois (Irwin & Downey, 1973, Ill. Nat. Hist. Surv. Biol. Notes No. 81: 1-60).

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FACTORS AFFECTING THE OCCURRENCE OF
MELANIS PIXE (RIODINIDAE) IN EXTREME SOUTHERN TEXAS

The lower Rio Grande Valley of Texas has a varied lepidopteran fauna including many neotropical forms that reach their northernmost points in this area. One of the least known of these is *Melanis* (= *Lemnax* = *Lymnas*) *pixe pixe* (Boisduval), Riodinidae. This medium-size butterfly (wingspan about 3.5 cm) has a velvet-black ground color with an apical yellow spot on each forewing. A single basal spot on each wing and six marginal spots on the hindwings are an intense scarlet color.

This species is neither illustrated nor mentioned in any of the standard American butterfly guides, i.e., Holland, Klots, Ehrlich & Ehrlich, or dos Passos. An illustration of *M. gynaeceas* Godm. & Salv., which may be an extreme version of *M. pixe*, may be found in *Biologia-Centrali-Americana* (Godman & Salvin, 1882: v. 38, pl. 110, fig. 3). Despite previous collections of this *M. pixe* in the Brownsville (Cameron Co., Texas) area (summarized below), the present report is believed to be the first published note on U.S. records of this species. The northernmost published record of this butterfly that I could find was in the state of Veracruz (Hoffman, 1940, Am. Inst. Biol. Mex. 11(2): 639-739), at least 420 km south of Brownsville. L. E. Gilbert (pers. comm.) has observed *pixe* at Cd. Mante, Tamaulipas, 380 km south of Brownsville.

In June, July and August of 1961, I observed this species in Brownsville. Larvae were found and reared to imago feeding on an introduced ornamental, guamuchil, *Pithecellobium dulce* (Roxb.) Benth. This leguminous shrub is native to Mexico and through Central America to Colombia and Venezuela (Little & Wadsworth, 1964, Common Trees of Puerto Rico and the Virgin Islands, Agric. Handbook 249, U.S.D.A.). Adult *M. pixe* are very poor fliers and are often seen hovering around the host plant. Their flight pattern is suggestive of many of the warning-colored day-flying moths.

Melanis pixe was first reported from the U.S. on 21 March 1956 by O. O. Stout in Brownsville. (This and the following records are from the files of R. O. Kendall.) Field collections of *M. pixe* occurred from 1957-1961; none were subsequently reported until the late 1960's, when C. A. Kendall sighted one. All U.S. records to date are from Brownsville. I saw no further specimens after the superabundance in 1961.

Possibly, the absence of *M. pixe* in 1962 and subsequent years resulted from the effects of the catastrophic freeze of 9-12 January 1962. Brownsville reported a low temperature of 19°F (12 January), the coldest since 1899. Massive damage to citrus groves and substantial damage to native vegetation resulted. This freeze undoubtedly was the most destructive to native wildlife and vegetation recorded (Heitzman, 1962, J. Lepid. Soc. 16: 249-150; James, 1963, Southwest. Nat. 8: 45-46.).

The first reported occurrence of *M. pixe* in the Brownsville area corresponded with one of the warmest periods on record in the same area. No severe freezes were recorded from 1952-1961 (lowest temperature 29°F); no freezing temperatures were recorded from 1954-1958, inclusive. The warm years of the mid-1960's again permitted the occurrence of *M. pixe* in the lower Rio Grande Valley.

Many butterflies of northern Mexico are found in southern Texas, but only under certain environmental conditions (Gilbert, 1969, J. Lepid. Soc. 23: 177-185). Populations of *M. pixe* may be completely eliminated by these severe freezes and must disperse from Mexico; on the other hand, populations may simply be so low in numbers and local in nature that detection is unlikely.

A puzzle yet to be solved is determination of the native larval foodplant of *M. pixe*. Adults flying around *Pithecellobium dulce* showed no attraction behavior toward Texas ebony, *P. flexicaule* (Benth.) Coult., a common tree in southern Texas; *M. pixe* larvae have never been found on this species. A specimen of Texas

ebony was less than 10 m from the smaller *P. dulce* that supported *M. pixe* larvae. *Pithecellobium dulce* has been reported common around Cd. Victoria, Tamaulipas (Robert Runyon, botanical voucher sheet 777, Univ. Texas at Austin Herbarium), 320 km south of Brownsville. There possibly has never been a native foodplant for *M. pixe* in the Brownsville area. Thus, *M. pixe* may have occurred in southern Texas only since the introduction of guamuchil.

ACKNOWLEDGMENT

I wish to thank R. O. Kendall for information on previous sightings of this species.

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NEW FOODPLANT AND OVIPOSITION RECORDS FOR *BATTUS PHILENOR* (PAPILIONIDAE)

Battus philenor (L.) feeds on several species in the plant family Aristolochiaceae. In the central and southern Appalachian regions of the eastern U.S.A., *Aristolochia serpentaria* L. is a predominant native foodplant species (Scudder, 1889, The butterfly flies of the eastern U.S. and Canada, 2: 1219-1364; Holland, 1898, The butterfly book, Doubleday, Doran & Co. New York; Forbes, 1960, Cornell Univ. Agr. Expt. Sta. Memoir #371). The northern range limits of *Battus philenor* probably are extended by feeding upon the introduced ornamental *Aristolochia siphon* L'Her or *Asarum* spp. In Texas, Kendall (1964, J. Lepid. Soc. 18: 129-157, and pers. comm.) reports only *Aristolochia longiflora* (Engelm. & Gray). Here we report feeding and oviposition by *B. philenor* on *Aristolochia serpentaria* and *A. reticulata* (Nutt.) in eastern Texas. These observations apparently represent new foodplant records for the state of Texas and the U.S.A., respectively.

During a collecting trip to the "Big Thicket" region of eastern Texas in late March, 1972, eggs and larvae of first through third instars of the pipevine swallowtail, *Battus philenor*, were found upon the small perennial *Aristolochia reticulata* in a longleaf pine forest near Camp Waluta, approximately 6 mi. NW of Silsbee between routes 92 and 69 in Hardin County. In addition, several females were seen ovipositing on these plants. Another trip during the following spring to the same area yielded similar observations. From 8 April 1973 through 13 April 1973, eggs, larvae of various instars and ovipositing females were abundant upon the *A. reticulata* (Fig. 1). Eggs were laid most frequently in groups of two, three or four per plant, though the number laid by an individual female on any one occasion ranged from one to seven per plant.

While following one particular female engaged in the characteristic 'ovipositional searching' flight between 12:25 and 13:00 hours on 12 April 1973, oviposition was observed upon *Aristolochia serpentaria*. Although *A. reticulata* plants were more abundant, none were selected by this female for oviposition, or even approached. Three *A. serpentaria* plants were supplied with one, three and two eggs respectively.

Although *A. serpentaria* is not apparently a widespread hostplant for *Battus philenor* in Texas, it is more common in other states to the northeast. *Aristolochia reticulata*, however, has not to our knowledge ever been reported as a foodplant of *B. philenor*. The explanation for the intensive use of *A. reticulata* in the Waluta site and the absence of records elsewhere probably stems from the fact that *A. reticulata* has a relatively restricted range. It is found in the humus of sandy soils of pine-hardwoods or pine savannahs only in eastern Texas, southwestern Arkansas



Fig. 1. *Battus philenor* female ovipositing upon *Aristolochia reticulata* 12 April 1973 in a long leaf pine savannah near Silsbee, Hardin County, Texas.

and northwestern Louisiana (Pfeifer, 1966, Ann. Mo. Bot. Gdn. 53: 115-196; Correll & Johnston, 1970, Manual of the vascular plants of Texas, Texas Research Foundation).

Specimens of *Aristolochia reticulata* have been deposited in the Bailey Hortorium at Cornell University. *Battus philenor* individuals which were found and reared upon the *A. reticulata* have been deposited in the Cornell Collection (Lot 1023; subplot 18).

ACKNOWLEDGMENTS

Thanks are extended to Geraldine Watson for identification of the two plant species, but most especially for her enthusiastic and valuable guidance in locating the many beautiful and priceless portions of the Big Thicket region of eastern Texas which were appropriate for our studies. The travel expenses were borne by N. S. F. Grant # GB 33398.

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BOOK REVIEW

THE SWALLOWTAIL BUTTERFLIES OF NORTH AMERICA, by Hamilton A. Tyler. 1975. Naturegraph Publishers, Healdsburg, Ca. vii + 192 p., illus. + 16 plates. Price \$5.95 (U.S.) paperback, \$9.95 cloth.

This book is a pleasant blending of the scientific and popular knowledge of the North American swallowtail butterflies. The geographic region encompassed extends from the arctic into the North American faunal region of Mexico and to the southern political boundary of that country. The author has chosen to include neotropical species as well as an aid to visitors to Mexico. The format is of a convenient, almost field guide size. There is a wealth of information presented in a rather informal manner. The usual taxonomic treatment appears with keys, wing venation diagrams, etc., but also included are biogeographical data, evolutionary speculations, mimicry, hilltopping, hybridization experiments and other interesting items. There is extensive information on distribution, food plants and immatures. A nice feature, not seen in many scientific books, is a discussion of the origin of the scientific names used to describe the members of the supergenus *Papilio*.

The author divides the swallowtails into the four genera: *Papilio*, *Eurytides*, *Parides* and *Battus*. These are then subdivided into species groups within each genus forming the basis for the book chapters. The genera *Parnassius* and *Baronia* are given only brief treatment as they are not true swallowtails. For each species, the various subspecies and forms are discussed, and information is provided such that similar appearing species may be differentiated. Data are then presented for habitat, flight period, food plants, early stages and distribution.

Interspersed throughout the text are line drawings of ova, larva and pupa. There are two sets of color plates which are composed of water color renditions of the principal species and many of the subspecies discussed in the text. The plates are certainly adequate and many present rather natural portrayals of the imagines. A "color errata" noting color registration shifts to be corrected in subsequent printings is included. There are three indices: a general index, an index of swallowtail names and an index of larval food plants. A "selected" bibliography appears at the end of the book which, while perhaps selected, presents in four pages a reasonably comprehensive treatment.

The informal style may aggravate some workers, but I found it quite refreshing. The book is certainly current and cites ongoing and incompleting taxonomic and breeding studies. Generally it appeared free from typographical errors. The only criticism that I would offer is the lack of inclusion of authority names when the scientific names of plants are listed. A few food plant omissions were noted, but these are of minor consequence. It would have been helpful if the undersides of all of the members of the Old World swallowtail group (*machaon-polyxenes-bairdii*, etc.) had been figured, as in many cases, the ventral surfaces contain the necessary diagnostic characters for reliable species separation.

This book is a useful addition to the library and should appeal to the amateur and serious collector alike as an informative and ready reference.

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A STUDY OF THE PENINSULAR FLORIDA POPULATIONS OF THE MONARCH BUTTERFLY (*DANAUS P. PLEXIPPUS*; DANAIDAE)

F. A. URQUHART AND N. R. URQUHART

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A number of contradictory reports have been published concerning the presence or absence of the monarch butterfly (*Danaus p. plexippus* (L.)) in the peninsular part of Florida (hereafter referred to as Peninsular Florida and being that portion of the State between Latitude 30°N–24°N) throughout the year. Some published reports indicate that the monarch butterfly is absent during the summer months while others report the presence of this species throughout the year (Urquhart, 1960). Brower (1961) reported breeding populations in January and throughout the spring and summer months (March through August).

To clarify this situation, since it forms an integral part of our complete investigation of the movements of this species throughout North America, a continuous study of the populations in Peninsular Florida was commenced in 1968 and carried out through 1973. The results of this six year study program are here presented.

PROCEDURE

With the active cooperation of our research associates (Urquhart, 1960) living in Florida, together with a number of field expeditions, a program of field observations, collecting of larvae, tagging of imagoes and recording of larval stages of development was set up in the following areas (Fig. 1): Area I (Orlando); Area II (Temple Terrace, Lithia, Palmetto, Bradenton, Sarasota); Area III (Fort Lauderdale, North Miami Beach, Homestead). Observations were made on the presence of imagoes and species of milkweed (*Asclepias*) at Area IV (Key Vaca and adjacent

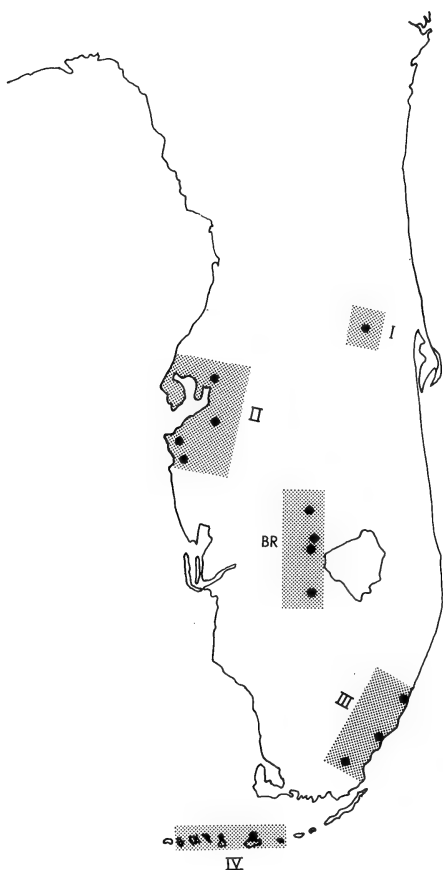


Fig. 1. Research areas: (I (Orlando); II (Temple Terrace, Lithia, Palmetto, Bradenton, Sarasota); III (Fort Lauderdale, North Miami Beach, Homestead); IV (Key Vaca); BR (area studied by Brower at Highland Hammock State Park, Lake Childs, Old Venus, 22 mi. SW Clewiston).

Keys). Larvae collected were reared (outdoors) to the imago stage and alar tagged (Urquhart, 1960) and released.

A specimen alar tagged and liberated at a particular time and later recaptured at some other place gave information as to the direction flown, distance travelled and the time interval involved. In addition, the total number of specimens tagged was recorded as well as the total of recaptures, in order to ascertain whether or not, in terms of percentage of recaptures, there was any significant movement within a given population.

RESULTS

Flight of Imagoes

During the autumnal migration, the majority of females in a moving population are in a state of ovarian dormancy (Urquhart, 1960). A small percentage of females, however, mate prior to moving southward or, in some cases, during the movement, and are capable of laying fertilized eggs on the milkweed plants of various species along the route of migration (Urquhart, 1960). It has been found that if these ovipositing females are kept under laboratory conditions, they will continue to lay their full complement of eggs. The female offspring, if maintained in the laboratory, do not enter a state of ovarian dormancy and hence will mate and lay viable eggs. Thus, a population of monarchs may be maintained in the laboratory throughout the year (Urquhart & Stegner, 1966). If, on the other hand, a female that is in the state of ovarian dormancy is held in the laboratory under ambient conditions, ovipositing does not take place nor do eggs develop in the ovaries, even after a period of five months. However, females in ovarian dormancy that were collected from the overwintering sites in California (Monterey) in January and held under ambient laboratory conditions developed eggs in the last week of February and laid viable eggs in March (Urquhart, 1960). As yet no significant research has been carried out as to the factors involved in initiating or depressing ovarian dormancy, although light period is suspected. Thus, a migrating population of monarch butterflies includes some gravid females and some in ovarian dormancy. In a particular area, such as Florida, one will encounter a population in which some of the individuals are part of a migrating population and capable of laying viable eggs; others may be in a state of ovarian dormancy and will continue their migration southward without ovipositing; while still others may be the offspring of ovipositing migrants, thus giving rise to what might be considered a "resident population."

As a result of the alar tagging program, which has been carried out in North America over the past 24 years, the release-recapture records indicate that a few migrants from eastern Canada and the eastern United States travel through Peninsular Florida (Fig. 2). One alar tagged migrant released in Grafton, Ontario, Canada was recaptured in Miami, Florida having flown south, a distance of 1223 mi. Another migrant alar tagged in Binghamton, New York was recaptured at Miami, Florida having flown south southwest, a distance of 1114 mi. A third migrant tagged at Port Hope, Ontario, Canada was recaptured in Havana, Cuba having flown south a distance of 1403 mi. A specimen tagged at Anna Maria, Florida in research Area II was recaptured in Miami, having flown

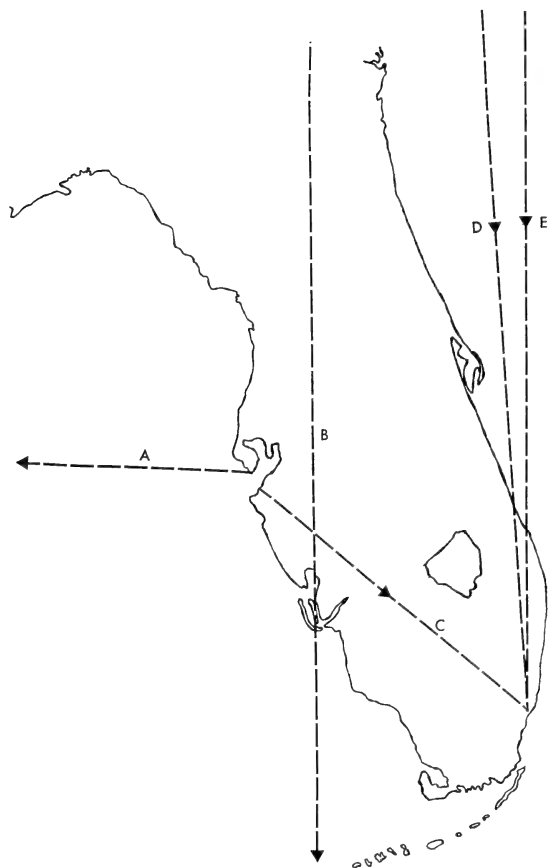


Fig. 2. Long distance migration records (release-recapture lines): (A) Miller Key to Kingsville, Texas; (B) Port Hope, Ontario, Canada to Havana, Cuba; (C) Anna Maria to Miami; (D) Grafton, Ontario, Canada to Miami; (E) Binghamton, New York to Miami.

southeast a distance of 195 mi. A migrant alar tagged at Miller Key in Area II was recaptured in Kingsville, Texas having flown a distance westward of 860 mi. All of these distances are measured as straight lines between the point of release and that of recapture. The actual route taken is, of course, not known.

Although two long flight records are reported for specimens alar tagged in Area II, most of the recaptures were for shorter distances and flights were in various directions (Fig. 3; Table 1).

Of a total of 4146 specimens tagged in Peninsular Florida, only 39

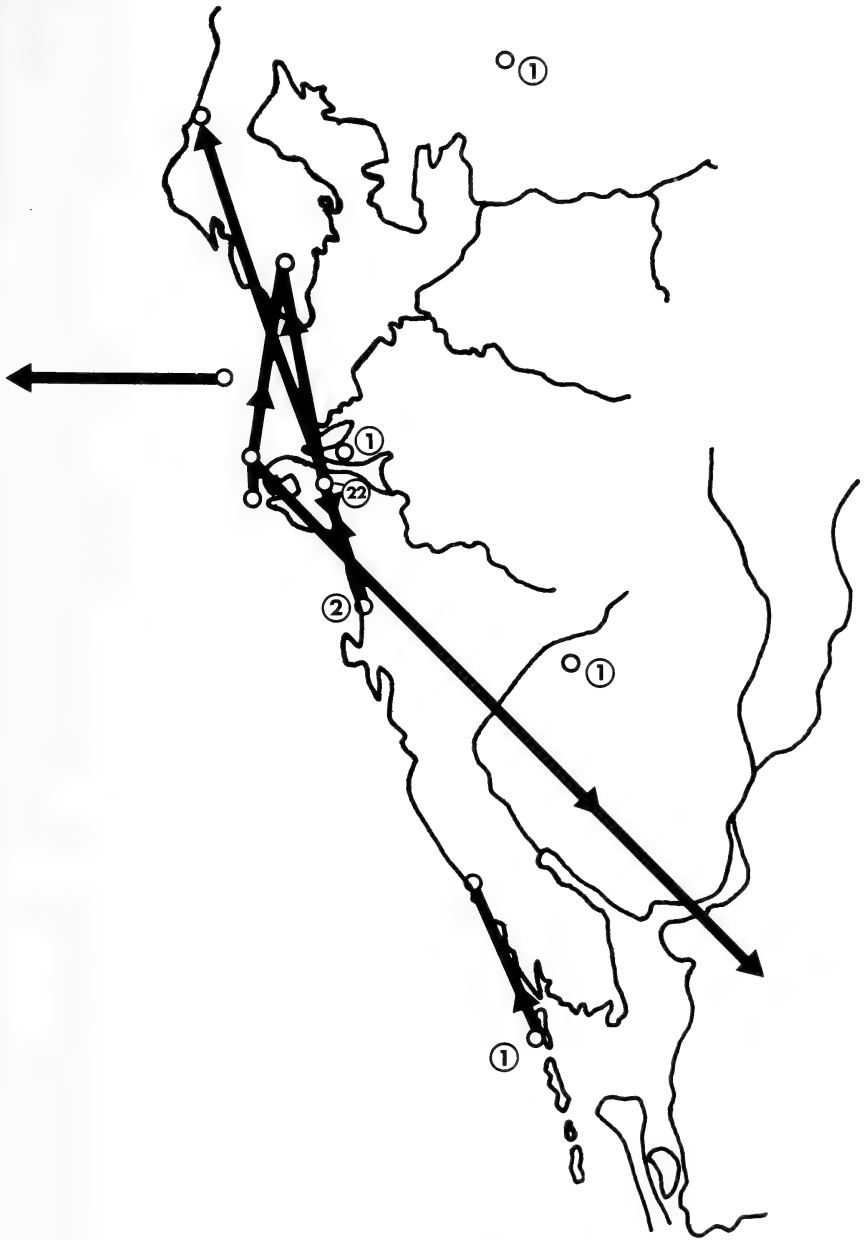


Fig. 3. Release-recapture lines for specimens tagged in Area II showing movement away from the area at various times of the year and the number of tagged specimens that were recaptured close to the site of tagging—indicated by a circle with enclosed number.

TABLE 1. Tagging results showing distances travelled, direction of flight and number of recaptures in each case.

Tagged at	Distance Travelled (Km)	Flight Direction	Number of Recaptures
Bradenton	0	0	22
Bradenton	28	WNW	1
Bradenton	13	SSE	2
Sarasota	16	N	1
Sarasota	0	0	2
Myakka State Park	0	0	1
Ft. Lauderdale	0	0	1
Coquina Beach	228	SE	1
Mullett Key	1003	W	1
Anna Maria	24	NNE	1
Palmetto	0	0	1
Boca Grande	21	NNW	1

were recaptured (.94%) even though the tagged specimens were released in well populated areas where the chances of recapture should have been much greater, as has been the case in other parts of North America during the migrating period (Urquhart, 1960).

Presence of Larvae

Brower (1961) recorded breeding populations of the monarch butterfly in the area marked BR (Fig. 1). These observations were made at: Highland Hammock State Park; east side of Lake Childs; Old Venus; and 22 mi. SW of Clewiston, given as the junction of highways 846 and 833. The observations were made during the months of March (25-31), April (2-30), June (15-30), July (7-31), and August (1-4). Brower also reported a breeding population in the same area in January.

During the years 1958-1973 inclusive, larvae were collected in the field and reared outdoors, the resulting imagoes alar tagged and released. The number of larvae collected each day was recorded and summated for a particular month. The number of larvae recorded varied for a particular month from one year to another. This was due to the variable activity of the field assistants, the size of the population in any one year and the restricted oviposition of a particular female or females with respect to the number of milkweed plants present. Thus, although a total of 116 larvae were collected in June of 1969, fewer were collected in June of 1970 and 1971. Hence, the data presented in Table 2 and the summation with imagoes in the histogram (Fig. 4) only indicate trends and not accurate field population densities for each year.

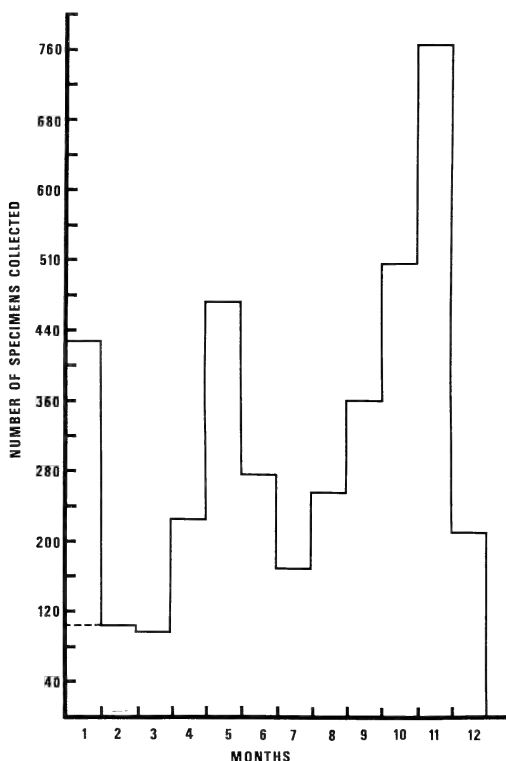


Fig. 4. Number of specimens collected during the entire research period for each month. Broken line in January indicating what was possibly the true population figure as explained in the text. Two peaks of abundance are noted.

Foodplant

The presence of a breeding population of monarch butterflies depends upon the presence of various species of the genus *Asclepias*, upon which the larvae feed.

Of the 21 species of *Asclepias* listed for Florida (Woodson, 1954), 15 occur in Peninsular Florida, the remainder being reported for the north-

TABLE 2. Number of specimens (larvae and imagoes) collected per month for all years (1968-1973).

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	220	16	17	48	202	122	58	169	198	158	59	92
	(208)	(88)	(78)	(177)	(269)	(155)	(112)	(87)	(142)	(358)	(706)	(118)
Total	428	104	95	225	471	277	170	256	340	516	765	210

ern portion of Florida here referred to as the Panhandle area. Brower (1961) recorded larvae feeding upon 4 species of *Asclepias*, namely: *tuberosa rolfsii*, *humistrata*, *tomentosa* and *curtisii*. Of these the most abundant were *tuberosa rolfsii* and *tomentosa*, the others recorded as uncommon. In addition to Brower's records, *verticillata*, which occurs in rather dry, wooded areas, and *lanceolata*, found in wet, marshy areas, are of common occurrence throughout Peninsular Florida. The remaining species occur as widely scattered plants and are recorded from only a few localities.

Unlike some species of *Asclepias*, such as *A. syriaca*, which occurs in dense growths, the plants of species found in Peninsular Florida tend to be widely separated from one another. There are some species, such as *humistrata* and *tuberosa*, found as flowering plants in home gardens, and much of the data recorded in this paper are based on larvae collected from such plants.

Whether or not the larvae of the monarch butterfly will feed on the foliage of all species of *Asclepias* is not known. Brower (1961) has recorded 4 species upon which larvae were found feeding. Urquhart (1960) has recorded 10 species of which 4 are found in Peninsular Florida (*incarnata*, *tuberosa*, *tomentosa*, *curassavica*), as well as 3 species of related genera.

From the above records one may assume, subject to further study, that the larvae of the monarch butterfly will feed on all species of *Asclepias*. Hence, breeding populations may occur in many areas of Peninsular Florida in addition to those recorded here, so long as temperature permits the survival of both the host plant and the larvae.

DISCUSSION

Areas of Concentration and Flight Directions

It has been well documented that the autumnal migrants follow a northeast to southwest flight direction (Urquhart, 1960). It has also been shown that although small breeding populations may occur south of Lat. 35°N, by far the greatest concentration of summer population build up takes place between Lat. 45°N and Lat. 35°N and east of Long. 100°. This is specifically correlated with the distribution of *Asclepias syriaca*, a species which, by the nature of its rhizomatous root system, grows in dense clusters often covering many acres of marginal land as well as appearing in considerable abundance along gravel roadways and railway lines (Fig. 5). Other species occur in this area of *syriaca* abundance, such as *amplexicaulis*, *exaltata*, *tuberosa* and *verticellata*, thus adding to the great abundance of host plants throughout the area indicated.

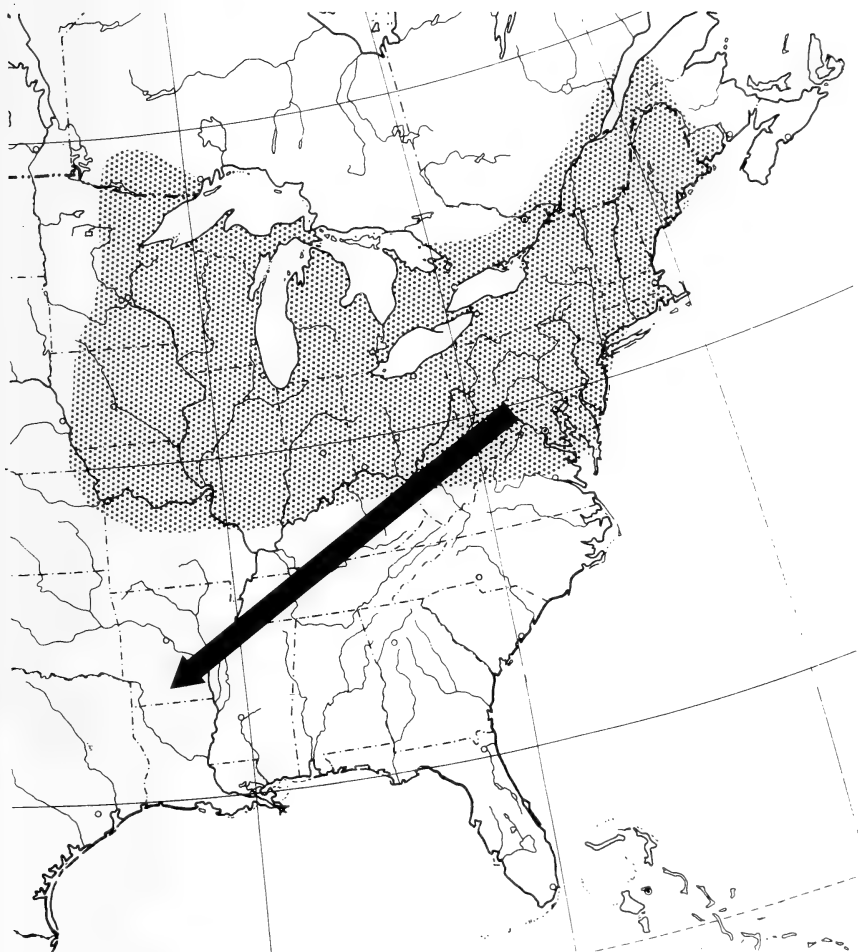


Fig. 5. Area of *Asclepias* abundance (stipled) and direction of monarch migration from this area to the southwest (solid arrow) accounting for the relatively meager migration through Peninsular Florida.

Since the line of autumnal migration is from northeast to southwest, as indicated by the arrow in Fig. 5, the majority of the autumnal migrants will tend to by-pass Peninsular Florida. Observations made on a number of field trips to northern Florida, as well as the eastern section of the United States (east of and including the Appalachian Highlands) have definitely indicated this trend. Therefore, relatively few autumnal migrants from the area of most abundant host plants travel down Peninsular Florida. There will be a certain small number of migrants emanating

from those areas where species of *Asclepias* occur in smaller numbers in the south and southeast parts of the continent; together, this constitutes a minority of the autumnal migrants.

If the above concept is correct, namely that Peninsular Florida is bypassed, then one would expect to find large numbers of migrants along the Florida Panhandle Gulf coast. This has been found to be the case (Urquhart, 1966). During the autumnal migration countless numbers of monarchs move west along the Gulf coast with great concentrations in the Apalachee Bay area at a time when relatively few specimens can be observed in the Gulf coast area of Peninsular Florida. Of those that do enter Peninsular Florida, field observations together with alar tag returns indicate that the movement is south and for the most part along the coast of the Gulf of Mexico.

If the Peninsular Florida populations move southward one would expect to find migrants in some of the islands of the Gulf of Mexico and, perhaps, in parts of southern Mexico and Central America. As a result of field expeditions to the Yucatan Peninsula of Mexico and Guatemala, both larvae and imagoes of the monarch butterfly were collected in the autumnal migration period (Fig. 6). Of the latter, many were definitely migrants as indicated by the colour change and scale loss (Urquhart, 1960). The situation in these areas is similar in all respects to that found in Florida.

It would therefore appear that the small, migrating population of monarch butterflies moving down Peninsular Florida, together with generations resulting from ovipositing migrants, travel via the offshore islands of Florida in the Gulf of Mexico and along the Florida Keys, eventually reaching Cuba. From Cuba, the flight continues from the area of Pinard el Rio to Yucatan, and from there to various parts of southern Mexico and Central America in which migrants in ovarian dormancy, gravid migrants, and generations of larvae and imagoes resulting from the latter occur (Fig. 6).

No large over-wintering concentrations of migrants in dormancy, as reported for California and observed in at least one area of Mexico (ms. in preparation), were located. It is assumed, however, that individuals from Yucatan and Guatemala, as well as other adjacent areas, will, during the vernal migration, travel northeastward, entering Cuba and eventually Florida in the spring and early summer, thus increasing the population of Peninsular Florida during this period.

Correlation Between Larval Population and Migrants

As pointed out in this paper and previously documented (Urquhart, 1960, 1966), migrant females may be in a physiological state which is



Fig. 6. Migration route from Peninsular Florida to Cuba and Yucatan. Migrant monarchs and larvae found at Chetumal, Flores, Morales and Guatemala as indicated. In addition to localities indicated in the figure, migrants and larvae were found at Villahermosa, Palenque, Zinacantan, Tuxtla and Oaxaca in the isthmus area of southern Mexico.

referred to as ovarian dormancy; or they may be capable of ovipositing wherever species of milkweed occur along the southward migratory route. Hence, larvae will occur from late summer (August) to late fall (November) along the migratory route so long as freezing temperatures do not occur, limiting the growth of milkweed (Urquhart, 1960). Ovipositing migrants reaching Peninsular Florida will oviposit on various species of milkweed and, so long as the temperature is suitable for larval growth and the host plant available, larvae and imagoes may be found throughout the year (Urquhart & Stegner, 1966).

Two peaks of monarch abundance (Fig. 4) occur throughout the year, a small peak in April-June and a larger one in August-November. The first peak is correlated with the advent of ovipositing vernal migrants, as discussed previously, and the second and larger peak with the advent of a much larger population of ovipositing autumnal migrants. Correlated with the occurrence of migrants, and hence a larger population of imagoes, is the presence of more abundant food plants as compared to conditions during the winter period. Decreased populations occur in January-March and July-August as the result of the decrease in the number of migrants. The meager population is, however, maintained as a result of the lingering presence of a few migrant stragglers as well as first and second generations resulting from gravid female migrants.

The rate of growth of the larvae during the winter period is reduced due in part to the lack of available host plants and partly to the effect of low temperatures lowering the growth rate. Concerning the latter, observations on various field expeditions during periods of low temperatures showed that larvae will drop from the host plant and remain on the ground in an inactive state until the return of higher temperatures.

Factors Limiting a Large Population in Peninsular Florida

Larval response in seeking host plants. Urquhart (1960) indicated, by movement tracings of larvae with respect to the ability of the larvae to locate the host plant when in close proximity to it, that they were unable to locate the host plant except by random movement. Experiments carried out in the field indicated that many larvae, when once dislodged from the host plant, were unable to locate the same plant or a substitute one when the plants were widely separated. As a result of numerous observations on various field trips through Peninsular Florida it is concluded that the various species of milkweed plants are widely separated in any growth area. Hence, many larvae would not complete the life cycle in most parts of Florida.

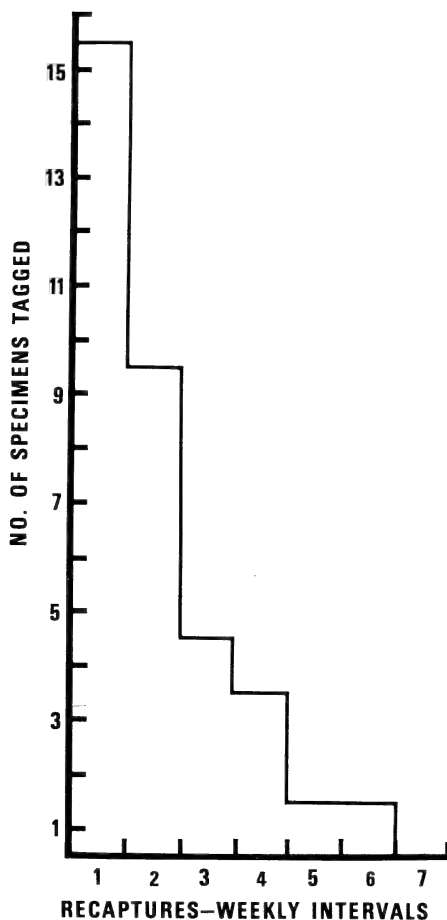


Fig. 7. Showing the rapid decrease in recapture of tagged specimens due to emigration from the area of release.

Insufficient food supply and competition with other species. Although there are a number of species of milkweed found in Peninsular Florida, there are not sufficient numbers of any one species, or of all species, to support a large population such as occurs in northeastern United States. Also, with the advent of low temperatures, particularly in areas north of the frost line (Lat. 28°N), many species of milkweed will drop their leaves and not resume growth until the following spring; in addition, many species die off during the winter period and resume growth the following spring (Woodson, 1954).

Brower (1962) has hypothesized competition for host plants with *Danaus gilippus berenice* (Cramer). However, in our six years of intensive field studies, during which time many hundreds of monarch larvae were collected and reared for migratory purposes, that were carried out through the entire calendar year in many localities throughout Florida (both Peninsular and Panhandle), there was no evidence of such competition. Throughout most of Florida, the larvae of *D. g. berenice* were scarce, only a few specimens being collected by our field assistants and ourselves, while monarch larvae, in many areas, were quite abundant. It is suggested that the observations of Brower were for a limited area and during a short period of the year during which place and time, *D. g. berenice* larvae were locally abundant.

Imago migration. It has been shown in this paper that relatively few alar tagged specimens were recaptured, even though all were liberated in areas of high human population, as compared to returns for other parts of the continent (Urquhart, 1960); further, that the majority of recaptures were made during the first two weeks following release with a marked drop in recaptures in the third and fourth weeks and none after six weeks (Fig. 7). From this it is concluded that the imago population does not remain in a given area but like the true migrants move away from the area to the south in the fall and winter and north in spring and early summer.

SUMMARY

1. Owing to the southwest pattern of the autumnal migration and the relationship of larvae to the presence of the abundant supply of milkweed plants in eastern North America, relatively few migrants pass through Peninsular Florida.

2. Female migrants that are in ovarian dormancy together with migrant males move southward or southwestward to Cuba and thence to the Yucatan Peninsula.

3. Gravid migrant females deposit eggs on species of milkweed along the migratory route.

4. Generations resulting from eggs deposited by gravid females move southward and southwestward, as in 2 above; the females in gravid state.

5. As a result of the paucity and scattered nature of the milkweed plants, limiting survival of larvae, together with the advent of low temperatures which prolongs larval growth period and reduces available food plants, and the movement southward of the imagoes, the monarch population in Peninsular Florida remains relatively low throughout the year.

6. A definite correlation exists between the number of larvae and imagoes and the autumnal and vernal migrations.

ACKNOWLEDGMENTS

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FUGITIVE COLOR IN THE MALES OF CERTAIN PIERIDAE

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In late June 1973 I collected a series of *Nathalis iole* Boisduval at Nicolls Town, North Andros Island, in the Bahamas. They were spread shortly after my return home and a curious fact was then immediately evident. The small, oval, androconial patch of each of the males, near the base of the costa on the upperside of the hindwing, was bright, vivid orange. In all our other males of *N. iole* this patch is dull yellow, regardless of whether they came from the West Indies (including New Providence Island in the Bahamas), the United States or Central America.

A month or so later Mr. Allan Watson of the British Museum was visiting us and I told him about this odd population. I showed him the series, the first time in several weeks that I had seen the specimens myself. The orange color of the androconial patches seemed to be much duller and less striking at this time than I had remembered it earlier. In late August, two months from when they had been captured, I examined the series once again. The orange color was completely gone, and the specimens were all perfectly ordinary-looking *N. iole*, with the androconial patches the usual dull yellow.

I then wrote to two colleagues, Dr. Lee D. Miller and Mr. F. Martin Brown, both of whom live in "*iole* country," and described the situation, asking them if they could catch and examine fresh *N. iole* males to see what color the patches were in their areas. They both reported them to be orange, as they had been in the Andros specimens.

In early June 1974 I took additional *N. iole* in the Bahamas, this time on Grand Bahama Island, at Pine Ridge, 4 mi. NE of Freeport. In July, just over a month since they were captured, the scent patches of the males were orange (although not as bright as I recall them in the Andros series); in August, two months after capture, the orange was gone (a slight trace in one specimen may have remained). Examination of specimens under a dissecting microscope in July showed nothing unusual other than a uniform orange tinge to the patch.

This color change in the androconial patch of male *N. iole* had been observed long ago by Gundlach (1881:100).

On North Andros in June 1973 I also caught a pair, male and female, of *Eurema* (*Pyrisitia*) *messalina blakei* Maynard. After they had been spread an examination showed that the male (but not the female) had a distinct pink bar on the underside of the forewing, running from near

the base distad for about $2/3$ of the inner margin, in interspace Cu_2-2A . Other *E. messalina* males in the collection, from the Bahamas, Cuba and Jamaica, had no pink on any of them.

I kept this curiosity in mind when in the Bahamas again in June 1974. On South Andros Island, near Driggs Hill, *E. messalina* was not uncommon and I obtained a series, examining each of them as it was caught. The males all had the pink bar.

On my return to Pittsburgh I examined again the now year-old male from North Andros. To my surprise the pink bar had disappeared completely. I had examined this male in April 1974 and am reasonably sure that the pink bar was still present, some 10 months after capture. Examination of my June 1974 specimens in August, two months after capture, showed that of eight males, the patch was absent in two, extremely faint in five, clearly visible in one.

When the newer specimens had been spread I examined the males under the dissecting microscope. The scales in the pink area were white and all seemed identical in structure to the scales in the white areas nearby on the wing, except that each one had its distal edge narrowly and sharply bright red, as though it had been dipped in red ink.

The situations in the two species are probably related. In both species only males are involved; and in both species the color is fugitive. It may also be significant that the ground color of *Eurema messalina* is white and the fugitive color of the bar is pink, whereas in *Nathalis iole* the ground color of the patch is yellow, which would appear orange if combined with pink. In other words, the transient pigment may be red in both, but appear as pink in *E. messalina* on the white ground, and as orange in *N. iole* because the patch substrate is yellow.

The transient color in *N. iole* is clearly associated with an androconial patch, a readily seen and morphologically distinct structure. The underside of the forewing near the inner margin, where the pink bar occurs in *E. messalina*, is also a common site of androconial structures. It seems at least possible that the pink color transiently indicates an androconial area in that species that otherwise is not characterized by any visible structural modification.

If this is indeed the case, then androconial patches or areas may be present in more species than we know. Ordinary visible scent patches are useful taxonomic structures, their presence, location and configuration providing valuable clues to relationships. If less easily visible patches also exist, their attributes could be just as useful once they are made known. Some of them may be transiently visible because of an evanescent pigment, as is presumably true of *E. messalina*. In some species

such pigments might be even more fugitive than in either of those reported here, so examination of males should be made when they are captured or as soon as possible thereafter.

It is even conceivable that androconial patches may exist without any ordinarily visible clue whatever, should the transient substance(s) associated with them be unpigmented. Perhaps such patches could be "developed," by prompt treatment with a suitable reagent that would render the substance visible; or perhaps submicroscopic structural differences exist in the scales, invisible under conventional magnification but showing up, say, in the scanning electron microscope.

Transient pigment need not always be associated with androconial areas. Clark & Clark (1951: 87) describe fugitive pink color in the North American pierid, *Euchloe olympia* Edwards, that may well be non-androconial. They make no mention of the sex of the individuals that show it, but the manner of their description suggests that it may be in both sexes; and the pink is found on wing areas where androconial patches rarely occur (anterior part of the hindwing underside; costal area of the forewing on both surfaces). From the Clarks' description we cannot yet rule out completely the possibility that the evanescent pink of *E. olympia* is androconially associated, but it seems unlikely.

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LARVAL MORPH VARIATION IN *CHLOSYNE LACINIA*
(NYMPHALIDAE)RAYMOND W. NECK¹

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Mature larvae of the patch butterfly, *Chlosyne lacinia* (Geyer), exhibit striking color polymorphism. First described by T. D. A. Cockerell in Edwards (1893) and illustrated by Neck et al. (1971), the three morphs are as follows: *rufa*, an all orange or orange-red form; *nigra*, an all black form; and *bicolor*, a form basically black as in *nigra* but with a prominent mid-dorsal row of orange to orange-red blotches whose proximity to each other gives the impression of a stripe. The black pigment is present in the cuticle while the orange pigment is in a deeper layer (hypodermis) that shows through window-like areas of the cuticle devoid of pigment.

Laboratory crosses utilizing adults of known larval phenotypes revealed that the larval color polymorphism involves two unlinked autosomal loci (Neck et al., 1971). At one locus *bicolor* (B) is dominant to *nigra* (b). At the second locus *rufa* (R) is dominant to non-*rufa* (r). The *rufa* allele is epistatic to the first locus; no phenotypic expression of the first locus occurs when the *rufa* allele is present at the second locus.

Although there are only three major morphs in this species, a variety of subtypes exists which indicate the influence of genetic modifiers and/or environmental factors. The most common variant is a *nigra* form with circular light yellow-orange spots of varying intensity at the base of each mid-dorsal spine. This phenotype, named *dot*, is pictured in Plate 1D of Neck et al. (1971). It may be the same form reported by Cockerell (in Edwards, 1893) and Gorodenski (1969) although the description by Cockerell ("with numerous yellow-white spots") could possibly refer to the *super-dot* form described below.

Nearly all *nigra* have a small spot at the base of each mid-dorsal spine. (42 of 50 or 84.0% *nigra* larvae collected 10 September 1972 at Austin were definitely *dot*; others had very small *dot*.) In some individuals it is inconspicuous enough to be unnoticed unless critically examined under a dissecting microscope. In other individuals the *dot* is so large as to create confusion with the *bicolor* morph. In most cases the *dot* of the *nigra* tends towards yellow whereas the block of the stripe in *bicolor* is more orange. In addition, a black mid-dorsal line present in those larvae is seen in the *bicolor* larvae only between the orange spots and

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TABLE 1. Parental larval phenotypes: black \times black.

brood number	Phenotypes of Progeny		
	black	dot	total
129	84	86	170
272	194	8	202
273	120	11	131
277	92	27	119
301	50	21	71

never in them. In dot nigra this line is seen between and entering the dot, continuing almost to the base of the spine.

Super-dot is also a variant of nigra with a yellow-orange spot at the base of each mid-dorsal, medio-dorsal, supra-spiracular and infra-spiracular spine. Super-dot also has a spot at the base of paired spines just above each proleg, a spot also present in bicolor and nigra. The more heavily yellowish-pigmented dot larvae also have yellow spots at the base of supra-spiracular spines, but they lack yellow at the base of medio-dorsal spines. A relationship between the dot and super-dot varieties may exist. One larva, collected as fourth instar was an extreme form of dot, i.e., very large spots at the bases of the mid-dorsal spines (but not others). This larva subsequently molted into a fifth instar super-dot form. Although dot larvae would thus appear to have a tendency to produce an abundance of yellowish spots, many dot phenotypes occur in fifth instar larvae.

Variation exists in the amount of melanin present in the cuticle. Nigra exhibits definite black and gray forms although intermediates occur that are difficult to place in either category. Dot larvae may be either gray or black, but all super-dot forms observed have been gray. The more evident dot larvae, however, are grays. The more intense pigmentation in the black form tends to cover up the dot, but it can still be observed in most specimens. Therefore, unless the genetic basis involves incomplete dominance or incomplete penetrance of a normally dominant allele, two separate genetic systems are involved. A form of bicolor exists with extensive melanization which obscures most of the orange. This form is sometimes difficult to distinguish from nigra, particularly in third and, sometimes, fourth instar. Inspection of less heavily melanized thoracic segments where the yellow-orange pigment can be seen more readily reveals such larvae as bicolor.

Intense melanization is also observed in rufa. Black pigmentation which is normally restricted to the base of various spines and inter-segmental membranes may be so intense that it is difficult to differentiate

TABLE 2. Parental larval phenotypes: dot \times dot.

brood number	Phenotypes of Progeny		
	black	dot	total
455	74	0	74
507B	288	13	301
516	44	15	59
517	72	36	108
559	70	24	94
570	62	0	62

it from nigra. Heavily pigmented rufa may be correctly determined as rufa by orange pigmentation which can be detected in areas around and ventral to spiracles. Also, rufa lacks the mid-dorsal black line present in the non-rufa morphs. A similar darkening appears in *Chlosyne harrisii* (Scudder) as the normally orange larvae of this species have been observed to be "nearly black at maturity, the fulvous being represented merely by a few dots and small spots" (Edwards, 1877). In this case, however, the imago was also strongly melanic; this has not been observed in *C. lacinia*.

Environmental conditions may exert a significant force in production of black, hidden-stripe and heavily melanized rufa forms. These forms are readily seen in laboratory cultures; they are quite rare in field populations. Caterpillars raised under crowded laboratory conditions have been noticed to be generally darker than caterpillars occurring in the wild (see Long, 1952, 1953, and references therein). Cooler temperatures are also known to produce larvae which are more heavily pigmented than larvae reared at warmer temperatures (David & Gardiner, 1962). On the other hand, dot are often seen and super-dot forms have been seen in natural populations. The occurrence of super-dot forms appears to be correlated with large population sizes. Although observations are limited, this may indicate a relaxation of selection pressures as reported for adult phenotype of *Melitaea aurinia* Rott. (Ford & Ford, 1930).

Attempts to determine the genetic basis of these forms have been inconclusive (Tables 1 and 2). Certain black \times black crosses yielded black and dot larvae in 1:1 and 3:1 ratios in addition to some broods highly skewed for black, i.e., very few dot. However, several dot \times dot crosses yielded broods with both black and dot larvae and some broods with only black larvae! The genetic basis of these forms is vague and may be highly influenced by environmental conditions as previously reported in the larvae of the arctiid moth *Utetheisa pulchella* L. (Kettlewell, 1964). Kettlewell (1944) reported results which he interpreted as being due

to the expression of a gene which is normally buffered in natural conditions but is released under artificial laboratory conditions. Major variation within morph classes in some amphibians (Volpe, 1961; Resnick & Jameson, 1963) has been shown to be the result of incomplete penetrance (variable expressivity) of various genes.

CONCLUSION

In *Chlosyne lacinia* genetic modifiers and environmental influences apparently act upon a basic three-phenotype polymorphic system. The result is to modify a genetically discontinuous system of variation into a system of nearly continuous variation. Such continuous variation was described for the larvae of this species by two workers (Koehler, 1927; Comstock, 1927, 1946).

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PORTABLE OUTDOOR CAGES FOR MATING FEMALE GIANT SILKWORM MOTHS (SATURNIIDAE)¹THOMAS A. MILLER² AND WILLIAM J. COOPER²U. S. Army Medical Bioengineering Research and Development Laboratory,
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Like many lepidopterists who colonize and study the saturniids, we must find time apart from professional duties and other daily activities to pursue our interest in this family of moths. Therefore, our rearing methods must be both efficient and reliable if we are to accomplish anything other than the mere maintenance of colonies. Although most of the saturniid species we have reared can be colonized for many generations without difficulty, we have at times had a particular problem obtaining fertile eggs to perpetuate existing colonies or to begin new ones. This problem has been a function largely of limited available time to ensure the mating of females either by hand mating or by the use of indoor cages. For this reason we undertook an evaluation of methods for the routine, unattended mating of female saturniids indigenous to our area. We decided beforehand that the tying out of virgin females and the use of various-size stationary cages or traps (Collins & Weast, 1961; Quesada, 1967; Villiard, 1969) were not suitable to meet our requirements. Our approach, therefore, was to construct and test a series of portable outdoor cages that could be substituted locally for tying out or stationary cages and could also be easily transported for use in remote field areas. These cages were designed to minimize or prevent the escape of females placed therein while permitting pheromone-seeking males access for the purpose of copulation.

MATERIALS AND METHODS

1973 Studies. The cages used during 1973 were fabricated from heavy-gauge galvanized metal screen (1.27 cm openings). Each cage was cylindrical and contained a series of interior and exterior baffles as shown in Fig. 1. All components were joined by soldering. The cages were spray painted inside and out, in a pattern of brown, green, and black, to camouflage them and minimize the probability of human tampering. We constructed cages of two sizes: (1) small cages with the cylindrical portion 23 cm in height and 23 cm in diameter and (2)

¹ The opinions contained herein are the private views of the authors and should not be construed as official or reflecting the views of the Department of the Army.

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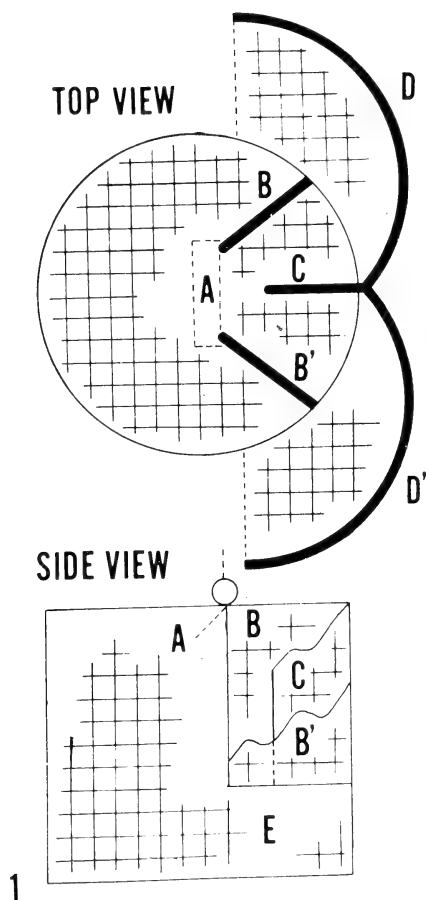
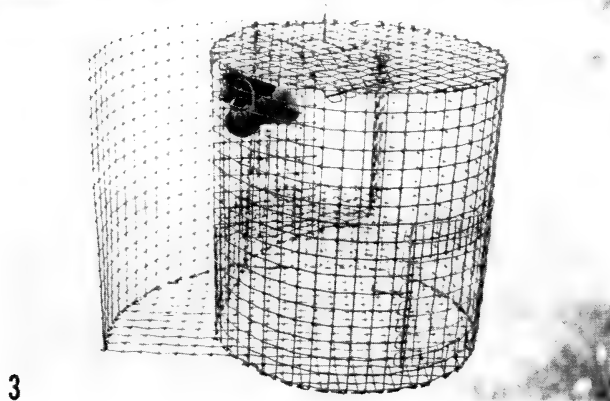
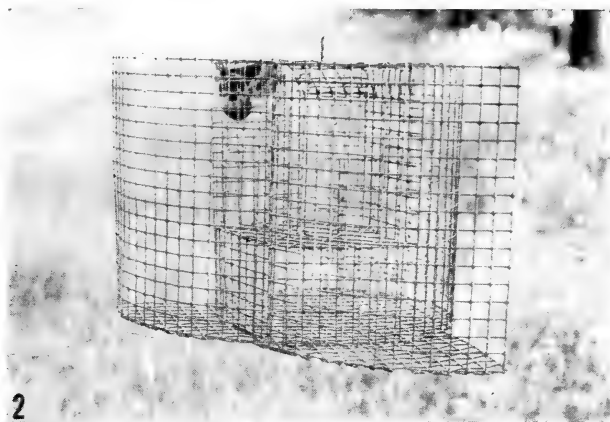


Fig. 1. Diagrammatic wire-screen mating cage: interior baffles (A, B, B', C); exterior baffles (D, D'); and dead space (E). Side view without exterior baffles shown.

large cages with the cylindrical portion 46 cm in height and 38 cm in diameter. The entrance and baffles were approximately proportional to the size of the cage. Additional details of construction are shown in Figs. 2 and 3. The studies during 1973 were conducted at Edgewood Arsenal, Harford Co., Maryland. The saturniid species we used were obtained as diapausing pupae from various sources (Table 1). All pupae were held over winter (1972-1973), during which they were exposed to outdoor temperatures from the time they were obtained until the emergence of adults. Newly emerged virgin females were placed



Figs. 2-3. Wire screen cages used during 1973: 2, front view of cage containing *C. promethea* female no. 1; 3, angular view of cage containing *C. promethea* female no. 4.

outdoors in mating cages on the day of emergence or on the following day. Small cages containing females of species in which males are day-flying [e.g., *Callosamia promethea* (Drury)] were placed outdoors in the late afternoon (after 1630 EST) but were not left overnight. Large cages containing females of species in which males are night-flying (i.e., all others in Table 1) were placed outdoors in the late afternoon or early evening, left overnight, and checked the next day between 0700 and 0800 EST or 1200 and 1300 EST. This schedule was used because work requirements precluded activities at other times. Cages were hung from tree branches such that they were about 1.5 m above ground. All females used in the cages were held indoors afterwards and allowed to oviposit so that the fertility of the eggs could be verified.

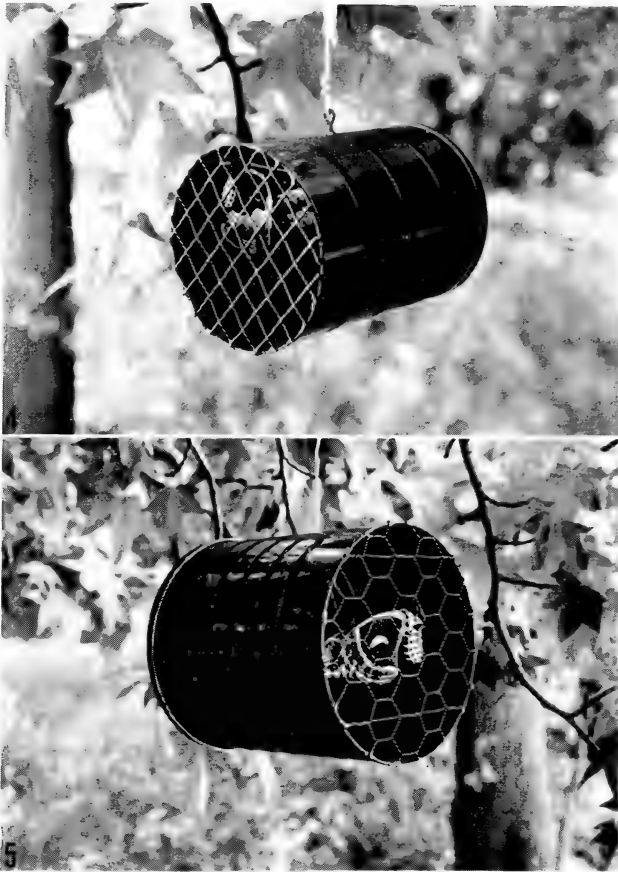
TABLE 1. Sources of saturniid moths used in mating-cage studies during 1973 and 1974.

Species	Source
1973 Studies	
<i>Antheraea polyphemus</i>	Diapausing pupae purchased from a dealer in fall of 1972.
<i>Actias luna</i>	Diapausing pupae reared in Harford Co. during summer of 1972.
<i>Hyalophora cecropia</i>	Diapausing pupae collected in Harford Co. during winter of 1972-1973.
<i>Callosamia promethea</i>	Diapausing pupae collected in Harford Co. and Portage Co. (Ohio) during winter of 1972-1973.
1974 Studies	
<i>Hyalophora cecropia</i>	Diapausing pupae reared in Harford Co. during summer of 1973.
<i>Callosamia promethea</i>	Diapausing pupae reared in Harford Co. during summer of 1973; and diapausing pupae collected in Harford Co. and Portage Co. (Ohio) during winter of 1973-1974.

1974 Studies. The design of the cages used during 1974 was based on the previous year's results, as will be discussed later. We used metal cans to construct tubular cages of two sizes: (1) small cages with a 14 cm length and 10 cm diameter and (2) large cages with a 17 cm length and 15.5 cm diameter. For both sizes, the metal ends of the can were removed. One of the open ends was covered with a plastic lid that allowed us to remove and replace female moths. The other open end was covered with galvanized metal screen, which was soldered into place. For the small cages the screen had diamond-shape openings measuring 1.27 cm on a side (Fig. 4). For the large cages the screen had hexagonal-shape openings measuring 1.5 cm on a side (Fig. 5). To minimize human tampering, these cages were also spray painted in a camouflage pattern of brown, green, and black. The studies during 1974 were conducted at Edgewood Arsenal and Havre de Grace, both in Harford Co., Maryland. The saturniid species we used and their sources are shown in Table 1. The large cages were used for female *Hyalophora cecropia* (Linnaeus), and the small cages were used for female *C. promethea*. The procedures for handling the pupae, the schedule for setting out the females in the cages and rechecking them, and verification of the fertility of the eggs were all the same as in the 1973 studies.

RESULTS

1973 Studies. During 1973 we used a total of 12 virgin females, representing four saturniid species, to evaluate the wire-screen mating cages



Figs. 4-5. Tubular cages used during 1974: 4, small cage showing *C. promethea* female no. 8 on diamond-shape screen; 5, large cage showing *H. cecropia* female no. 2 on hexagonal-shape screen.

(Tables 2 and 3). Each of the two *Antheraea polyphemus* (Cramer) females attracted a male and mated with no apparent difficulty. Neither of the females moved from their original positions in the cages, even though the first of these did not attract a male until the third night. The first two female *Actias luna* (Linnaeus) also attracted males and mated without apparent difficulty. The third female of this species escaped from the cage during the first night. This was not totally unexpected, since this particular female was a very excitable individual and had escaped from the cage the previous day while being held indoors. The single female *H. cecropia* did not attract, or at least did not mate with.

TABLE 2. Results of studies using various saturniid females in large, wire-screen mating cages. Edgewood Arsenal, Harford Co., Maryland, 1973.

Female Number	Date Female Emerged	Night		Moths Mated	Eggs Fertile
		Female in Cage	Male Attracted		
<i>Antheraea polyphemus</i>					
1	9-V	10-V	12-V	+	+
2	19-V	20-V	20-V	+	+
<i>Actias luna</i>					
1	15-V	15-V	16-V	+	+
2	18-V	19-V	19-V	+	+
3	20-V	21-V	— ¹	—	—
<i>Hyalophora cecropia</i>					
1	30-V	31-V	1-VI ²	+	+

¹ Female escaped from cage during night of 21-V.² No male attracted outdoors; female mated with reared male that emerged indoors on 31-V.

any males during the first night. The cage, containing this female, was brought indoors the following morning and left there until noon. By noon, a male *H. cecropia*, which had emerged indoors the previous day, entered the mating cage and copulated with the female. With the exception of the one female *A. luna* that escaped, we obtained large numbers of fertile eggs from each of the foregoing females. The six female *C. promethea* all attracted males and successfully mated (Table 3). In two cases the males did not enter the cage but mated with the females through the screen. In one case, two males found their way into the cage, although only one of them mated with the female. In another instance we were unable to bring the cage indoors after mating had occurred, and the moths evidently escaped during the night. We obtained

TABLE 3. Results of studies using *Callosamia promethea* females in small, wire-screen mating cages. Edgewood Arsenal, Harford Co., Maryland, 1973.

Female Number	Date Female Emerged	Afternoon		Moths Mated	Eggs Fertile
		Female in Cage	Male Attracted		
1	2-VI	2-VI	3-VI	+	+
2	4-VI	4-VI	4-VI ¹	+	+
3	4-VI	4-VI	5-VI	+	+
4	7-VI	8-VI	8-VI	+	+
5	7-VI	8-VI	8-VI ¹	+	+
6	8-VI	8-VI	8-VI	+	— ²

¹ Male did not enter cage; mated with female through screen.² Mated moths left in cage overnight (8-9-VI); both escaped.

TABLE 4. Results of studies using *Hyalophora cecropia* females in large tubular mating cages. Edgewood Arsenal (EA) and Havre de Grace (HDG), Harford Co., Maryland, 1974.

Female Number	Date Female Emerged	Night		Cage Location	Moths Mated	Eggs Fertile
		Female in Cage	Male Attracted			
1	8-VI	8-VI	— ¹	EA	—	—
2	9-VI	9-VI	10-VI	EA	+	+
3	9-VI	9-VI	11-VI	HDG	+	+
4	10-VI	10-VI	11 & 12-VI ²	EA	+	+
5	11-VI	11-VI	— ³	EA	—	+
6	13-VI	13-VI	14-VI	EA	+	+
7	13-VI	13-VI	13-VI	EA	+	+
8	13-VI	13-VI	14-VI	HDG	+	+
9	15-VI	15-VI	15-VI	HDG	+	+
10	16-VI	16-VI	17-VI	HDG	+	+
11	17-VI	18-VI	18-VI	HDG	+	+
12	18-VI	19-VI	19-VI	HDG	+	+
13	22-VI	22-VI	22-VI	HDG	+	+
14	22-VI	22-VI	22-VI	HDG	+	+

¹ No male observed; female oviposited night of 11-VI; eggs not fertile.

² Female mated with a different male each night; deposited fertile eggs after each mating.

³ No male observed; female oviposited night of 14-VI; eggs fertile.

a large number of eggs from five of the female *C. promethea*. Since the male *C. promethea* are day-flying, we were able to make observations as they arrived in the area of a caged female. Two or three males were usually attracted to each female, and they flew in apparent random directions until contacting the cage. Once they encountered the cage, they maintained contact and moved in a circular manner around it. Then they either found the entrance or contacted the female as it rested on the outer portion of the cage. On two occasions, as mentioned earlier, the males mated with the females directly through the wire screen. Those males that found the entrance were not particularly aided by the exterior baffle (Fig. 1) because their persistent contact with the cage caused them to fly into the entrance without actually contacting the exterior baffles.

1974 Studies. During 1974 we used 14 female *H. cecropia* and 10 female *C. promethea* to evaluate the tubular mating cages (Tables 4 and 5). Thirteen of the female *H. cecropia* successfully attracted males, mated and deposited fertile eggs (Fig. 6). One female *H. cecropia* deposited eggs on the wire screen of the cage during the fourth night. No male was observed mated with this female, and the eggs were not fertile. Another female *H. cecropia* also deposited eggs on the wire screen of the cage during the fourth night, but these eggs proved to be

TABLE 5. Results of studies using *Callosamia promethea* females in small tubular mating cages. Edgewood Arsenal (EA) and Havre de Grace (HDC), Harford Co., Maryland, 1974.

Female Number	Date Female Emerged	Afternoon		Cage Location	Moths Mated	Eggs Fertile
		Female in Cage	Male Attracted			
1	27-V	28-V	28-V	EA	+	+
2	27-V	28-V	29-V	EA	+	+
3	8-VI	8-VI	8-VI	EA	+	+
4	8-VI	8-VI	8-VI	EA	+	+
5	9-VI	9-VI	9-VI	EA	+	+
6	10-VI	10-VI	10-VI	HDC	+	+
7	11-VI	11-VI	12-VI	EA	+	+
8	11-VI	11-VI	12-VI	EA	+	+
9	11-VI	12-VI	12-VI	HDC	+	+
10	16-VI	16-VI	16-VI	HDC	+	+

fertile even though no male was observed copulating with this female. A third female *H. cecropia* copulated with two separate males (Fig. 7) during the second and third nights in the cage and deposited fertile eggs after each mating. Each of the 10 female *C. promethea* (Table 5) attracted a male, mated, and deposited fertile eggs.

DISCUSSION AND CONCLUSIONS

The studies conducted during 1973 demonstrated to us that it was possible, through the use of the wire-screen mating cages, to obtain fertile eggs of *A. luna*, *A. polyphemus* and *C. promethea*. The information on the single female *H. cecropia*, although obtained under indoor conditions, demonstrated that a male of this species will enter the cage and mate with a female. The time and effort required during the studies were minimal, even though we used several females of some species to collect data on efficiency. Where a single fertile female would suffice to provide eggs for a colony, the time required would be even less. We found that the schedule required for setting out the cages and rechecking them could be made compatible with working hours.

Despite these successes, we recognized certain shortcomings in the design of the wire-screen cages and the requirements for their use. First, the virgin female moths can escape, although the frequency of this occurrence appears to be very low because of their general quiescence prior to mating. Second, the cages had to be checked daily because after mating the female moths become active enough to eventually find their way out of the cage. Because of these shortcomings and the observed ability of *C. promethea* to copulate through the wire screen, we designed



Figs. 6-7. *Hyalophora cecropia* mated pairs during 1974: 6, female no. 6 showing typical copulation through screen; 7, female no. 4 showing copulation with second male and eggs deposited on screen after previous mating.

and successfully tested the tubular mating cages the following year. The wire screens used in the tubular mating cages appear to present no barrier to copulation when a male arrives at the cage. The tubular mating cages precluded the escape of females and obviated the requirement to recheck them daily. This constituted a definite advantage because our professional duties sometimes required us to be away for several days at a time. It would appear to be possible to set out a caged virgin female and have no requirement to recheck the cage for a week or more. Within this time period, even if the female mated on the first night or day and deposited eggs on the wire screen, we could still return and remove the

eggs before they hatched. We did not evaluate this concept during 1974, but plan to do so during a subsequent season. In addition, we plan to evaluate the concept of placing developing female pupae (in their original cocoons) in tubular mating cages and leaving them unattended while they emerge, attract males, mate, and deposit eggs on the wire screen. If this technique proves successful, it will permit an even longer period (perhaps two weeks) between setting out and returning to collect the eggs. With one exception, we did not use these tubular mating cages operationally during 1974, because we had obtained sufficient numbers of fertile eggs during the experiments with *H. cecropia* and *C. promethea*. In subsequent seasons, however, we plan to incorporate the use of these cages into our routine system for rearing saturniids.

One of the large tubular mating cages was used operationally in south Texas (5 mi. S George West, Live Oak Co., 28-September-74, 0845 CST), where one of us (TAM) set out a virgin female *Eupackardia calleta* (Westwood). The female was left unattended in the cage, although observations were made from nearby. Seven *E. calleta* males, which are morning fliers, were attracted within 10 min, and one of them copulated through the wire screen without difficulty. The use of this cage made it possible to easily obtain fertile eggs to colonize this species, and also provided us with data on an additional saturniid species.

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LARVAL FOODPLANTS, SPATIAL AND TEMPORAL
DISTRIBUTION FOR FIVE SKIPPERS (HESPERIIDAE)
FROM TEXAS¹

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Although fairly common at times, *Decinea percosius* (Godman), *Chiomara asychis georgina* (Reakirt), *Timochares ruptifasciatus* (Plötz), *Xenophanes trixus* (Stoll) and *Cabares potrillo* (Lucas) are among the most uncommon skippers in collections from Texas. Local larval foodplants in the Gramineae, Malpighiaceae, Malvaceae, and Verbenaceae are given for the first time. Records of specimens collected by others, unless otherwise stated, are from personal correspondence or communication. Biological arrangement follows dos Passos (1964), and botanical arrangement, Gould (1969).

Decinea percosius (Godman) 1900

First recorded from the United States by Freeman (1948) who collected a ♂ at Brownsville, Cameron Co., Texas, 28 Nov. 47. The following year he and Otto Buchholz collected 50 examples (42 ♂, 8 ♀) between Brownsville and Southmost, 4 & 7 April 48. So far as we can determine, it was not collected again in Texas until 1969.

Based on available data, this species appears to be only a periodic resident of extreme south Texas. In nature, it most likely feeds on broad-bladed grasses. It may have a larval or pupal diapause, or perhaps only a retarded immature development during winter months. Three broods are indicated. First adults emerge in late March and early April. The 2nd brood appears from late June to early July, and the 3rd from mid-October to late November. Peak emergences are in early April, late June, and early November.

Rearing records. At a spot near Southmost, SE of Brownsville, Rickard collected 1 ♀, 8 Nov. 69. The following day at the same spot, he collected 1 ♂, 1 ♀, and Kendall took 3 ♀. On 10 Nov. at this location Kendall collected 4 more

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♀, one of which was demonstrating oviposition behavior, and it was kept alive for possible egg production in the lab. Fifty-three eggs were deposited on *Stenotaphrum secundatum* (Walt.) Kuntze, GRAMINEAE: 10 Nov. (8), 14 Nov. (13), 15 Nov. (10), 16 Nov. (3), and 17 Nov. (19). Some eggs were preserved, and the remaining eggs started hatching the morning of 21 Nov. A few hatched each morning thereafter for about 10 days. First instar larvae readily ate *S. secundatum*. Most of the larvae died, however, in 2nd instar and the remainder in the 3rd instar. The exact cause of death was undetermined, but climatic conditions were suspect. Humidity in the lower Rio Grande Valley is very high, especially at night. In the rearing facility at San Antonio it was relatively low.

At the same Southmost location on 4 April 70, Rickard collected 7 additional specimens (5 ♂, 2 ♀). From one confined female, about 20 eggs were obtained on ryegrass, *Lolium perenne* L., GRAMINEAE. After one day the ♀ was placed in a killing jar and kept as a cabinet specimen. Eggs hatched 15–16 April and readily ate *L. perenne*. On 25 April 70 Rickard gave Kendall two of these larvae, one of which was in process of molting. Because the grass blade had dried around the larva, some difficulty was experienced in completing the molt; it died later and was preserved. The remaining larva, 2nd instar when received, ate *L. perenne*, *S. secundatum* and *Cynodon dactylon* (L.) Pers. It molted on 8, 15 & 25 May and pupated 16 June. A ♀ emerged about 0645 CDT 26 June 70. It was interesting to note that a formal tent or shelter was not constructed by the larva until it was fully mature. At this time it remained head down in the shelter pending final defecation after which it pupated head up. It was also noted that feeding was largely at night.

The remaining larvae kept by Rickard were switched to Johnsongrass, *Sorghum halepense* (L.) Pers., GRAMINEAE, and all died during pupation, probably from malnutrition. These were reared in Houston, Texas where the relative humidity is comparable to that of the lower Rio Grande Valley area.

Other Texas records. CAMERON Co.: Brownsville and vicinity: J. R. Heitzman found it fairly common during the period 19 June–1 July 69; Joseph F. Doyle III, collected 1 ♂, 18 June 70; Rickard collected 3 ♂, 1 ♀, 21 March and 4 ♂, 5 April 70; Kendall saw one 22 Oct. 72. HIDALGO Co.: Relampago, Rickard collected 2 ♂, 18 Oct., 2 ♂, 1 ♀, 19 Oct. and 1 ♂, 30 Oct. 71.

Chiomara asychis georgina (Reakirt) 1868

First recorded for the United States by Skinner (1901); collected by Irvin Runyeon from southern California to the Arizona border. It is well established in Cameron and Hidalgo counties of southern Texas and ranges up the coast to Harris Co. and inward to Bexar Co. Three and possibly 4 broods are indicated. There appears to be an immature semi-diapause during January and February even though adults have been collected in each month of the year except February; the known larval foodplant is deciduous.

Rearing records. While collecting in Bentsen-Rio Grande Valley State Park (B-RGVSP), Hidalgo Co., 29 Aug. 69, Rickard observed a female ovipositing on the foliage of *Malpighia glabra* L., MALPIGHIACEAE. Examination of the plant disclosed 2 larvae in leaf shelters, one was lost, the other produced a ♀ on 25 Sept. 69. Kendall collected a larva feeding on this plant in Santa Ana National Wildlife Refuge (SANWR), Hidalgo Co., 13 Nov. 71; it pupated 6 Dec. but died before emergence. On 11 Sept. 72 at McAllen, he collected another larva; it pupated 20

Sept. and a ♀ emerged 29 Sept. 72. The larva of this species may feed on other Malpighiaceae such as *Thryallis angustifolia* (Benth.) Kuntze found in Bexar Co., and *Janusia gracilis* Gray found in far western Texas, New Mexico and Arizona over which area the insect ranges.

Other Texas records. BEXAR CO.: Roy W. Quillin, Cibolo River in NE Bexar Co., 1 ♂, 21 Aug. 60; at his home in San Antonio, 1 ♂, 19 Aug. 65. CAMERON CO.: H. A. Freeman (1951), Brownsville, June and Aug. Roy O. & C. A. Kendall, Brownsville, 1 ♂, 3 April 57; 1 ♀, 4 Dec. 64; 1 ♂, 29 Oct. 65; 1 ♀, 25 Nov. 66; Harlingen, 5 ♂, 2 ♀, 20 Oct. 65. J. W. Tilden, Brownsville and vicinity, 4, 17-19 Oct. 63; 4 mi. W of Boca Chica, 2 ♂, 26 Oct. 63; nr. Brownsville, 1 ♂, 1 ♀, 13 Nov. 63. Joseph F. Doyle III, Brownsville, 1 ♀, 21 Dec. 67. M. A. Rickard, Brownsville, 2 ♂, 2 Sept. 67; several on 17, 18 and 31 Aug. 69; 1 ♂, 7 Sept. 69; 2 ♀, 18 Oct. 69; 2 ♀, 9 Nov. 69; 1 ♀, 4 April 70; 1 ♂, 17 Aug. 70. HARRIS CO.: John B. Vernon, Houston, 1 ♂, 23 Oct. 71. HIDALGO CO.: H. A. Freeman (1951), Pharr, March-June and Aug.-Dec. Roy O. & C. A. Kendall, B-RGVSP, 4 ♂, 1 ♀, 22 Nov. 62; Madero, 1 ♀, 11 Jan. 72; SANWR, 1 ♂, 14 Jan. 72; Mission, 1 ♂, 12 Sept. 72; McAllen, 1 ♂, 22 Oct. 72. J. W. Tilden, B-RGVSP, 1 ♂, 10 Nov. 63; SANWR, 1 ♂, 11 Nov. 63. Fay H. Karpuleon, nr. McAllen, 1 ♂, ? Dec. 65. J. R. Heitzman, SANWR, several, 21 & 24 June 66. M. A. Rickard, SANWR, 1 ♂, 1 ♀, 31 Aug. 67; 1 ♂, 5 Oct. 68; 1 ♀, 6 Oct. 68; 2 ♀, 4 July 69; 1 ♂, 26 July 69; 1 ♂, 3 April 70; 2 ♂, 17 May 70; 2 ♂, 1 ♀, 18 Aug. 70; 1 ♂, 12 Sept. 70; 1 ♀, 15 Aug. 71; 1 ♂, 29 Oct. 71; 1 ♂, 31 Oct. 71; B-RGVSP, several, 15, 16, 17, 24, 25, 29 & 30 Aug. 69 and 6 Sept. 69; 1 ♂, 14 Aug. 71; Madero, several, 25 Oct. 69; 1 ♀, 9 Nov. 69. KLEBERG CO.: Roy O. & C. A. Kendall, nr. Kingsville, 1 ♂, 23 Aug. 64. LIVE OAK CO.: E. M. & S.F. Perkins, nr. Lake Corpus Christi State Park (LCCSP), 1 ♂, 10 Nov. 62. M. A. Rickard, hwy. 9 nr. Mathis, 1 ♀, 9 March 69. SAN PATRICIO CO.: J. W. Tilden (1974), Welder Wildlife Refuge, 1 ♂, 13 Oct. 63 (in ROK coll.); 1 ♂, 2 Nov. 63. J. R. Heitzman, LCCSP, one or more, 16 June 68.

Timochares ruptifasciatus (Plötz) 1884

Recorded from the United States for the 1st time by Skinner (1901); collected by Irvin Runyeon from southern California to the Arizona border. Its distribution in Texas seems to be restricted to Cameron and Hidalgo counties where it is well established. It has been collected each month except December and only a few times in January and February. Rearing has disclosed a larval diapause. The deciduous local larval foodplant *Malpighia glabra* L., MALPIGHIACEAE, is grown as an ornamental in extreme southern Texas where its fruits are prized for making jellies. This explains why Freeman (1951) found the skipper mostly in city flower gardens. Comstock (1953) observed a ♀ oviposit on a malpighiaceae vine in Mexico. He reared it through, described and illustrated the egg, last instar larva and pupa. He was unable to identify the larval foodplant except as to family.

Rearing records. At Brownsville, 10 Nov. 69, Kendall found a single 1st instar larva on juvenile leaves of *Malpighia glabra*. It had made a rudimentary shelter by cutting and folding over a portion of the tender new leaf. In the lab the larva continued to feed on this plant and pupated 19 Dec. 69; a ♀ emerged 11 Jan. 70. Rearing was conducted at laboratory temperatures ranging from 50°-75° F, a comparable temperature range for outdoor temperatures in Brownsville

at that time of year. Humidity, however, was not comparable. Two more larvae were collected on this plant 15 Oct. 71 in SANWR. These were reared in a semi-outdoor environment. They pupated on 7 and 12 Jan. 72, and 2 ♀ emerged, one on 29 Jan., the other 7 Feb. 72. Kendall revisited SANWR 12 Jan. 72 and found 1 last instar larva; it was preserved. On 8 Sept. 72 he collected a ♀ at Mission, Hidalgo Co., confined it with *M. glabra* and obtained 7 eggs, 4 of which were preserved. The remaining eggs hatched 12 Sept. 72. Larvae were placed on a living plant in the lab garden. Only 1 larva could be found when examined 23 Oct. 72; it was brought into the lab where it died 22 Nov. 72. Again 20 Nov. 73, 3 mi. E of Harlingen, Cameron Co., Kendall collected 2 larvae eating *M. glabra*. These were sleeved on a living plant in the lab garden on 1 Dec. 73. Upon returning from an extended field trip 5 March 74, examination showed one larva had died, the other had just pupated; a ♂ emerged 18 March 74. Rickard collected a pupa 22 March 70 on *M. glabra* in B-RGVSP; a ♀ emerged 30 March 70.

Other Texas records. CAMERON Co.: H. A. Freeman (1951), Brownsville, 1 ♂, 1 ♀, 29 Aug. 44. J. W. Tilden (1974), Brownsville, 1 ♂, 19 Oct. 72. Rickard, Brownsville, 2 ♂, 14 Aug. 69; 1 ♂, 18 Oct. 69; 1 ♀, 19 Oct. 69; 1 ♂, 21 March 70; 1 ♂, 23 March 70; 1 ♂, 4 April 70; 2 ♀, 5 April 70; 1 ♀, 17 Aug. 70; 1 ♀, 19 Oct. 71. Roy O. & C. A. Kendall, Brownsville, 1 ♂, 19 Oct. 72; 1 ♀, 22 Oct. 72. HIDALGO Co.: H. A. Freeman (1951), Pharr, 1 ♀, 30 Aug. 44; 3 ♂, 21 Oct. 44; 1 ♀, 25 Aug. 46. Rickard, B-RGVSP, 1 ♀, 24 Aug. 69; 1 ♂, 6 Sept. 69; Madero, 1 ♂, 19 Oct. 69; SANWR, 1 ♀, 17 May 70; 1 ♂, 15 Aug. 71. W. W. McGuire, Mission, several, 3 & 4 Sept. 72. Roy O. & C. A. Kendall, Mission, 6 ♂, 2 ♀, 9 Sept. 72; 4 ♂, 1 ♀, 10 Sept. 72; 6 ♂, 1 ♀, 11 Sept. 72; 3 ♂, 12 Sept. 72.

Xenophanes trixus (Stoll) 1784

Barnes & McDunnough (1913) published the 1st record for the United States; 2 ♂, 2 ♀, May and June from Brownsville, Texas; year and collector not given. Freeman (1951) gives an uncited Skinner record for July in Brownsville. So far as we can determine it was not collected again in Texas until 1968 which tends to indicate a periodic residency in the state. Local collection data indicates 3 and possibly 4 broods. Larvae probably feed through the winter months when temperatures are mild; a local freeze may destroy the temporary population.

Rearing records. Near Southmost, SE of Brownsville, Kendall observed a ♀ demonstrating oviposition behavior around *Malvaviscus drummondii* Torr., MALVACEAE, 9 Nov. 69. This specimen avoided capture but another ♀ was taken and kept alive for egg production. Confined with *M. drummondii* twigs it deposited 30 eggs the following day and died 11 Nov. Young larvae soon ate holes through the micropile but died before escaping from the egg shell. Also on 9 Nov., 1 3rd instar larva was found hiding in a very rudimentary shelter on *M. drummondii*; it continued to feed sparingly in the lab until 24 Jan. 70 when illness was obvious; it died 26 Jan. and was preserved.

Unaware of Kendall's findings, Rickard observed and captured, 28 Feb. 70, a ♀ ovipositing on juvenile leaves of *M. drummondii* at the same Southmost spot. He also found one late instar larva on the plant in a poorly constructed leaf nest, same as Kendall had observed. This larva molted 2 March and pupated 12 March. An adult emerged 30 March but escaped in his home and was never found.

Rickard gave the live ♀ and egg collected 28 Feb. to Kendall who obtained

additional eggs: 1 March (27), 3 March (5), 4 March (1), 5 March (25). The ♀ was killed 8 March and kept as a cabinet specimen. Eggs were placed in an unheated room. By 22 March the embryo had completely developed and some larvae had eaten through the micropile, but all died before completing the hatching process. In a separate effort, 21 March 70, Rickard experienced the same disappointment. Low humidity is now suspect as the cause of death.

Other Texas records. CAMERON CO.: J. R. Heitzman, nr. Brownsville, 2 ♂, 21 June 69; 1 ♂, 24 June 69; 1 ♂, 25 June 69; 1 ♂, 1 ♀, 26 June 69. Roy O. & C. A. Kendall, Brownsville, 1 ♂, 7 Nov. 69; 3 ♂, 8 Nov. 69; 1 ♀, 10 Nov. 69; nr. Southmost, 17 ♂, 2 ♀, 9 Nov. 69; 13 ♂, 3 ♀, 10 Nov. 69. M. A. & S. Rickard, Brownsville & vicinity, 1969: 1 ♂, 2 ♀, 27 July; 1 ♂, 17 Aug.; 1 ♂, 18 Aug.; 1 ♂, 1 ♀, 31 Aug.; 2 ♂, 7 Sept.; 10 ♂, 4 ♀, 18 Oct.; 2 ♂, 1 ♀, 19 Oct.; 4 ♂, 5 ♀, 25 Oct.; 3 ♂, 26 Oct.; 9 ♂, 8 ♀, 8 Nov.; 2 ♂, 1 ♀, 9 Nov.; 2 ♂, 13 Dec. 1970: 4 ♂, 2 ♀, 28 Feb.; 4 ♂, 4 ♀, 21 March; 2 ♂, 2 ♀, 4 April; 1 ♀, 5 April; 5 ♂, 8 ♀, 24 May; 1 ♂, 17 Aug.; 1 ♂, 11 Sept. 1971: 2 ♂, 2 ♀, 19 May; 5 ♂, 20 May; 3 ♂, 6 July; common on 21 Aug., 18 and 19 Oct.; 2 ♂, 30 Oct.

Cabares potrillo (Lucas) 1857

First recorded for Texas and the United States by Weeks (1904); Brownsville, Texas, summer 1903, *leg.* [Wm. H.] Doll. This species is generally restricted to the lower Rio Grande Valley in Texas. It seems to be best established in Hidalgo Co. where its deciduous larval foodplant, *Priva lappulacea* (L.) Perse, VERBENACEAE, is most abundant. There appear to be 3 full broods with considerable overlapping in September, October and November. Based on limited rearing, it would seem the larvae feed through the winter months with growth and development greatly retarded. It has been collected each month except February and July.

In Mexico, nr. Cd. Mante, Tamaulipas, Kendall observed several ♀ ovipositing on this same plant 20 Jan. 74. Examination disclosed first instar larvae on several small plants at that time. It will be noted that the time frames of these 2 locations are comparable even though one is neotropical, giving stability to residency of the species in Texas.

Rearing records. Kendall collected a ♀, 13 Oct. 68, at SANWR and kept it alive for eggs. Earlier, Rickard had informed Kendall of seeing a ♀ oviposit on an unknown plant at this location. Based on his description, it was easy to locate the larval foodplant, *P. lappulacea* (det., Dr. Marshall C. Johnston, University of Texas, Austin). The ♀ deposited eggs on this plant on 14, 15 & 19 Oct. They were not inventoried but were estimated to be about 25, some of which were preserved. Hatching started 17 Oct. Larvae were placed on a protected potted plant outdoors. Later, it was discovered a moth larva had eaten most of the foliage. Only 2 *Cabares potrillo* larvae could be found 2 Nov.; they were glossy black and quite small; one soon died, the other pupated 25 Nov. and a ♀ emerged 27 Dec. 68.

A return visit to SANWR 9 Nov. 68 produced 6 larvae on this plant. Larval shelters are constructed in such a way that they are very difficult to find and recognize. Insufficient foodplant was brought back to the lab and it became necessary to preserve 1 larva. The others pupated 25 Nov. (2), 26 Nov. (1), 1 Dec.

(1), and 3 Dec. (1); the last one was injured and was preserved. Adults emerged: 1 ♂, 30 Dec. 68; 2 ♀, 7 Jan. 69; 1 ♂, 10 Jan. 69.

Other Texas records. BEXAR Co.: Roy O. & C. A. Kendall, San Antonio, 1 ♂, 4 April 59. CAMERON Co.: Roy O. & C. A. Kendall, 10 mi. SE of Brownsville, 1 ♂, 1 April 57; Santa Maria, 1 ♂, 14 Nov. 71. Tilden (1974), Brownsville, 1 ♀, 30 Oct. 63; Santa Maria, 1 ♂, 18 Oct. 72 (doubtless there are other county records unknown to us at this time). HIDALGO Co.: Freeman (1951) found it well established at Pharr and vicinity from 1946–1959; specimens were taken in Mar., June, Oct., and Nov. Joseph F. Doyle III, SANWR, 1 ♂, 21 Sept. 68; 3 ♂, 19 Oct. 68; 1 ♂, 1 ♀, 24 Nov. 68. J. R. Heitzman, SANWR, 1 ♀, 21 June 66; 1 ♂, 24 June 66; several on 22, 24 & 25 June 68; B-RGVSP, several, 25 & 28 June 68. Roy O. & C. A. Kendall, SANWR, 1 ♂ 22 June 68; 3 ♂, 1 ♀, 21 Oct. 68; 1 ♂, 13 Oct. 68; 2 ♂, 9 Nov. 68; 1 ♀, 11 Nov. 68; Mission, 1 ♂, 10 Oct. 72. M. A. & S. Rickard, 1968: 2 ♂, 2 ♀, 5 Aug., 1 ♂, 6 Aug.; 2 ♂, 21 Aug.; 1 ♂, 7 Sept.; 1 ♂, 1 ♀, 21 Sept.; 2 ♂, 1 ♀, 5 Oct.; 2 ♀, 6 Oct.; 1 ♂, 1 ♀, 12 Oct.; 1 ♂, 19 Oct.; 1 ♂, 1 ♀, 9 Nov.; 1 ♂, 10 Nov.; 1 ♂, 16 Nov.; 2 ♂, 24 Nov.; 1970: 1 ♀, 19 March; 1 ♂, 22 March; 1 ♂, 1 ♀, 17 May; 1 ♂, 29 Oct. 71.

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We wish to thank the U. S. Department of the Interior, Fish & Wildlife Service, Bureau of Sport Fisheries & Wildlife, Albuquerque, New Mexico, and the Texas Parks and Wildlife Department, Interpretation & Exhibits Branch, Austin, Texas, for providing the necessary permits to conduct basic biological research on the Lepidoptera in the national refuges and state parks. We are especially grateful to the local personnel of these Departments for their courtesy and assistance in conducting these continuing studies of Texas Lepidoptera. We are also grateful to those who furnished collection data for inclusion in this paper.

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COLLECTING COCOONS OF *CALLOSAMIA SECURIFERA*
(SATURNIIDAE)¹

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Little was published on *Callosamia securifera* (Maassen) until Ferguson's work in 1972. Skinner (1920) first synonymized the names *C. securifera* and *C. carolina* Jones, but the moth was long considered a subspecies of *C. angulifera* (Walker). Because the diurnal males are not phototaxic and the species inhabits remote coastal areas of southeastern United States, specimens are still comparatively uncommon in collections. It is my purpose to provide some helpful advice for anyone wishing to collect cocoons of this moth.

Choosing Correct Habitat

I have searched successfully for cocoons of *C. securifera* in Florida, Georgia, South Carolina and North Carolina. However, most of what is said in this paper applies mainly to the habitats in South Carolina where I have collected most.

The hostplant is sweetbay (*Magnolia virginiana* L.), but the tree ranges much farther north along the Atlantic Coast, west along the Gulf Coast and inland from both coasts than does the moth (Peigler, 1975). It is, therefore, advisable to go to or near localities where *C. securifera* is known to occur. Sweetbay may be easily confused with red bay (*Persea borbonia* (L.) Sprengel), but the latter does not have white undersides of leaves which help to recognize sweetbay.

There will be many areas near or between known localities of the moth which will appear suitable for searching because of the presence of the host tree, but may be unproductive. Expansive fields with standing water throughout may have hundreds of sweetbays, but I have never found even an empty cocoon in such places. Even if *C. securifera* were present, it would be very hard to find cocoons unless the population was high because of the high density of host trees on which to look. Other habitats where I have not found cocoons are thin woods under towering pines and mixed hardwood forests. Perhaps females prefer to fly and oviposit in the open. The most rewarding habitats are along

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roadsides in which the sweetbays are small and in the open and a lot of areas can be checked with an automobile.

Choosing Correct Season

In the fall or early winter searching may be very slow because many green leaves are still on the host trees. This situation exists until early December in the Carolinas and Georgia. On the other hand, even the tip leaves may be lost by March so that sweetbays are not readily seen. At such times I spend more time looking for the host than the cocoons themselves. Therefore, December and January are the best times to plan a collecting trip.

Comments

Dr. R. B. Dominick reports that he usually finds only one cocoon per tree (see Ferguson, 1972, p. 242). I would agree that this is true for the areas in South Carolina where he collects (northern Charleston Co. and eastern Berkeley Co.). However, in western Berkeley Co. where I collect most often, the population of the moth is probably much higher, and I seldom find isolated cocoons. The most viable number of cocoons I found on a single tree was six, and several times I found four and five. Often an empty female cocoon is found along with viable ones, indicating that females often mate and begin ovipositing on the same tree on which they fed as larvae. Usually over 90 percent of the sweetbays examined will have no cocoons hanging on them.

The populations may fluctuate or move. One winter I found 18 viable cocoons along a highway in western Berkeley Co. during three days of searching. The following winter I found 60 viable cocoons in four hours along the same stretch of road. This past winter the population was again high in that area.

Cocoons may occur on a tree from 1-20 ft. above ground level, but most are about 5 ft. Most sweetbays in the areas where I have collected are secondary growth sprouts from cut trees, and if a cocoon is too high to reach, the thin tree may be easily bent over. Brown (1972 and pers. comm.) searches tall sweetbays in central Florida with binoculars.

It is important to train one's eyes to look for hanging clumps of red-brown sweetbay leaves among green ones. The weight of a swinging cocoon detaches leaves from the stem so that cocoons seldom are covered with green, living leaves. The leaves on old cocoons of the previous season are bleached or have weathered away. A collector

looking for whitish cocoons will probably find more empty than viable ones.

Few insects feed on sweetbay, but chewed leaves may not mean *C. securifera* is present. Grasshoppers or larvae of *Papilio palamedes* Drury may have done the damage. In southeastern North Carolina I have seen larvae of *Epimecis* sp. (Geometridae) feeding commonly on this tree in summer. Not all large cocoons on sweetbay may be *C. securifera* because larvae of the saturniid *Antheraea polyphemus* (Cramer) sometimes move from adjacent red maples (*Acer rubrum* L.) to spin their cocoons on sweetbay. Often nests or egg sacs of large spiders, including the green lynx (*Peucetia viridans* (Hentz)) and a yellow species of Thomisidae, are attached with sweetbay leaves to stems. The tendrils of *Smilax* spp. vines commonly hold dead sweetbay leaves up in trees. The collector should examine possibilities closely so that a *C. securifera* cocoon is not overlooked.

ACKNOWLEDGMENTS

I wish to thank Dr. Richard B. Dominick and Mr. Charles R. Edwards for initial help in searching for cocoons of this moth. Drs. Merle Shepard and G. R. Carner of Clemson University helped with the manuscript.

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A GYANDROMORPHIC *LYMANTRIA DISPAR* (LYMANTRIIDAE)

It should not be too surprising to find a gyandromorphic Gypsy moth (*Lymantria dispar* (L.)) among the hundred thousands that have been defoliating trees in New Jersey the last few years. A single gyandromorphic, adult female was caught 6 July 1974 in Glendola, Monmouth Co., New Jersey in a light trap put up by the College of Agriculture, Rutgers University. The left antenna is female and the right, male. It is otherwise a normal specimen without any other deviations showing. The specimen is in the Rutgers Collection. Dr. J. P. Reed kindly loaned it to me for study.

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WING COLOR VARIATION IN *CALLOSAMIA* (SATURNIIDAE)¹

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The genus *Callosamia* Packard is comprised of three sexually dimorphic species. *Callosamia promethea* (Drury) is melanic with males almost black and females a wine-red color. *Callosamia securifera* (Maassen) and *C. angulifera* (Walker) have brown males and orange females although the former species is lighter and suffused with yellow. Adults of the latter two species also differ seasonally in that the spring or overwintering forms of both sexes are light and the summer forms are dark. Such seasonal variation has been oversimplified in past literature. It is the purpose of this paper to discuss in greater detail these wing color variations.

Although *C. promethea* does not have seasonal forms as in the other two species, there is color variation. In males the area beyond the postmedian line on the underside of the wings may be either bright red or blue-gray. Both color forms, and intermediates, were found among males collected in spring and summer from southeastern Pennsylvania.

Orange females of *C. promethea* may occur among populations with normal dark red females. Young (1968) and Baldy (1890) reported such populations occurring in Ulster Co., New York and on Mt. Catawissa, Pa., respectively. The possibility of hybridization is unlikely because of effective temporal isolation. Orange *C. promethea* females are possibly mutations in which the gene (or genes) governing reddishness is not expressed.

The pair of *C. angulifera* which Ferguson (1972, pl. 22, fig. 3, 4) uses to represent summer adults are scarcely darker than spring ones. In upper South Carolina the summer adults of both sexes are nearly as dark as *C. promethea* and the males have obsolete discal marks as in *C. promethea*. The winter of 1973-74 was very mild in South Carolina, and the adults of that spring varied through the entire spectrum from light to dark. This included specimens from wild and reared cocoons (kept outdoors all winter) as well as those coming to lights. Apparently, adults are darker when wing scale formation in the pupa occurs under comparatively high temperatures. In fact, *C. angulifera* cocoons which I overwintered in the refrigerator (40°F = 5°C) yielded dark adults

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that match the summer form. The same was true for adult hybrids of *angulifera* ♂ × *promethea* ♀, although some of their darkness may be attributed to *C. promethea* parentage. Cocoons of the saturniid *Actias luna* (L.) which I kept at no lower than 40°F during the winter also produced adults similar to the summer form of that species.

The effect of the mild winter of 1973-74 was further illustrated in the *C. securifera* population in Berkeley Co., South Carolina. Spring adults began flying in mid-April instead of late April, as they usually do, and most were dark. Although a few golden spring males and blackish summer males emerged from a lot of about 20 cocoons collected in March 1974, most did not fit either form and were intermediate.

Ferguson (1972) stated that females of *C. securifera* from Florida are paler than those collected from further north. However, specimens in my collection from Florida and both Carolinas do not follow this pattern. Possibly the Florida material available to Ferguson was faded.

In conclusion, seasonal variation in *Callosamia* is due apparently to effects of temperature on pupae and is not clear-cut without intermediates. There is no constant geographical variation in any of the three species, although seasonal extremes in *C. angulifera* may be greater in the South.

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I wish to thank Drs. John Morse and G. R. Carner for reviewing the manuscript and offering helpful suggestions.

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THE GENUS *COPABLEPHARON* IN TEXAS, WITH DESCRIPTION
OF THREE NEW SPECIES (NOCTUIDAE)

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Four species of the genus *Copablepharon*, still unrecorded from Texas, fly in this state. Three of these four species are new and are described in this paper.

Copablepharon grandis Strecker 1875

Fig. 1

Lep. Rhop. Het., 129.

My records for this species are as follows: Paducah, State owned Matador Wildlife Management Area, Cottle Co., Texas: 8 Sept. 1966, 4 ♂; 11 and 13 July 1967, 3 ♂, 3 ♀; 22 Sept. 1968, 1 ♂. These were identified by comparison with a pair of specimens in the Canadian National Collection. There are also, in the collection of the American Museum of Natural History, 1 ♂ and 1 ♀ collected at El Paso, El Paso Co., Texas by A. H. & S. K. Rindge.

Fig. 1 unfortunately fails to show the definite contrast between the pale sulfur yellow of the forewings and the white of the hindwings.

***Copablepharon albisericea* A. Blanchard, new species**

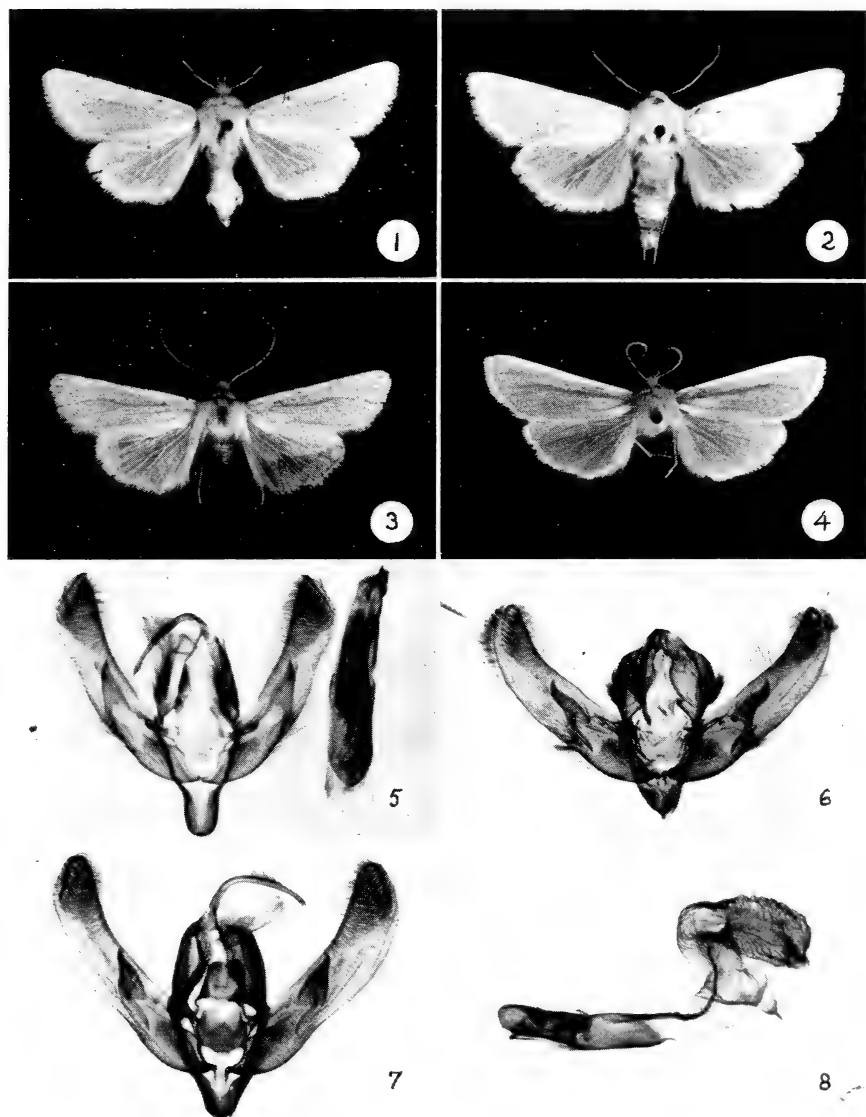
Figs. 2, 5, 9, 13, 14

Head, collar, thorax, tegulae, forewings above, hindwings above and beneath, legs, abdomen shiny silky white (Fig. 2). Forewings beneath more or less soiled with olivaceous in their basal halves between radius and fold. Male antennae weakly serrate, with hair length about half of shaft diameter. Female antennae simple, pubescent. Antennae of both sexes clothed with white scales above, orange below. Wing expanse = 40–43 mm.

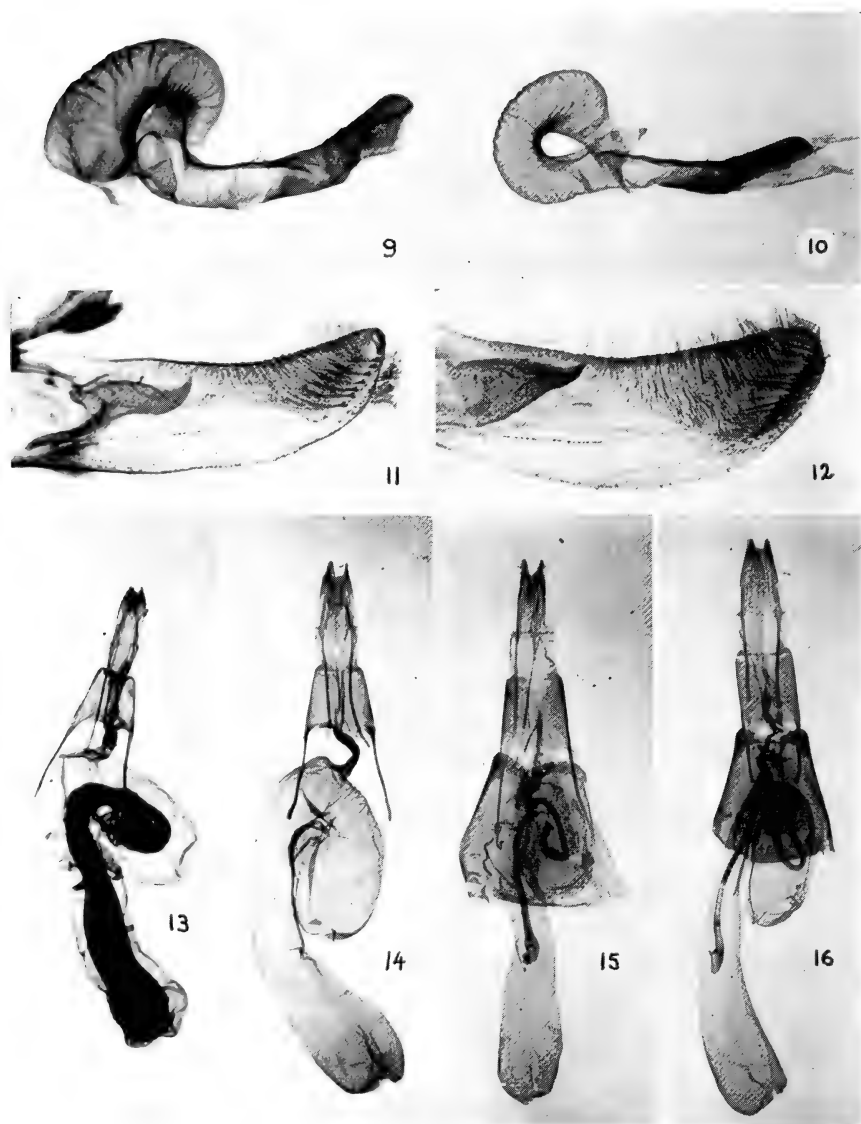
Male genitalia (Fig. 5): Uncus long, cygnate, not dilated in its middle; sides of tegumen broad, penicillus lobes well developed; vinculum narrow with rounded margin; valves long, slender, narrowest two-thirds distance from base where ventral margin and costa are slightly concave, clasper with broad base, tapering to a point; corona of 17–20 spines aligned along distal margin of valve, except near tip where 3–5 get crowded together; clavi slender, digitate, slightly dilated distally; juxta broad, lightly sclerotized; sclerotization of lateral and dorsal parts of annelus at least equal to that of juxta; aedeagus stout, one small conical cornutus located at apex of small diverticulum of vesica (Fig. 9).

Female genitalia (Figs. 13 & 14): Ovipositor cone shaped, lobes clothed near their apex with short, stout setae; anterior apophyses a little longer than sclerotized part of eighth segment collar; posterior apophyses almost twice as long as this collar; ductus bursae short, weakly sclerotized; bursa membranous, with an expanded lateral arm on the right side about half as long as left arm; ductus seminalis from near base of right lateral arm.

Holotype: Male, Canadian, State owned Gene Howe Wildlife Management Area, Hemphill Co., Texas, 27 Sept. 1968 collected by A. & M. E. Blanchard, deposited in the National Museum of Natural History (No. 73431).



Figs. 1-8. *Copablepharon* spp.: 1, *C. grandis* ♀, Paducah, Texas, 11 July 1967; 2, *C. albisericea* ♂, holotype, Canadian, Texas, 27 Sept. 1968; 3, *C. serraticornis* ♂, holotype, Paducah, Texas, 8 Sept. 1966; 4, *C. gillaspys* ♂, holotype, Padre Island National Seashore, 28 Sept. 1973. Figs. 5-7: ♂ genitalia, aedeagus omitted: 5, *C. albisericea* (A. B. 3555); 6, *C. serraticornis* (Slide COPA 6 in C. N. C.); 7, *C. gillaspys* (A. B. 3612). Fig. 8: *C. gillaspys* aedeagus with incompletely inflated vesica (A. B. 3613).



Figs. 9-16. *Copablepharon* spp.: Figs. 9 & 10: Aedeagus with inflated vesica: 9, *C. albisericea* (Slide COPA 5 in C. N. C.); 10, *C. serraticornis* (Slide COPA 6 in C. N. C.). Figs. 11 & 12: Distal part of valve showing corona: 11, *C. serraticornis* (Slide COPA 6 in C. N. C.); 12, *C. gillaspyi* (A. B. 3612). Figs. 13-16: Female genitalia: 13, *C. albisericea* (A. B. 3252); 14, *C. albisericea* (A. B. 3556); 15, *C. serraticornis* (A. B. 3552); 16, *C. gillaspyi* (A. B. 3554).

Paratypes: All from Canadian, Hemphill Co., Texas: 27–30 Sept. 1968, 17 ♂, 3 ♀, collected by A. & M. E. Blanchard, 8 of these ♂ are in the American Museum of Natural History; 27 & 28 Sept. 1968, 37 ♂ collected by D. F. Hardwick, in the Canadian National Collection.

C. albisericea is readily distinguished from *C. alba*, the other white species of this genus: *C. alba* is the only described species of the genus having a very short uncus.

Copablepharon serraticornis A. Blanchard, new species

Figs. 3, 6, 10, 11, 15

Head, collar, thorax, tegulae pale ochreous yellow, darker on vertex, collar and anterior thorax; paler on front, and metathorax (Fig. 3). Male antennae strongly serrate, with each segmental process developed into a thin edge extending laterally and supporting numerous bristles a little longer than shaft diameter. Widest portion of each serration about 2.5 times as wide as narrowest portion. Female antennae simple, very weakly pubescent. Antennae of both sexes clothed above with scales concolorous with front, beneath orange. Forewings above concolorous with thorax; a pale, faint grayish streak along cubitus; fringes concolorous. Hindwings above varying from same hue as forewings but much paler to pale buff; fringes slightly paler than disc. Beneath same hue as above but paler. Wing expanse: Male 36–40 mm; female 40–45 mm.

Male genitalia (Figs. 6, 10, 11): Very close to those of *C. albisericea*, differing from them as follows: Uncus very slightly dilated in its middle; clavi a little stouter and shorter; base of clasper narrower; ventral margin of valve convex all along; corona (Fig. 11) with 11–13 spines in a line which diverges from distal margin of valve as it approaches ventral margin. Vesica (Fig. 10) smaller.

Female genitalia (Fig. 15): Similar to those of *C. albisericea*, differing as follows: Setae on ovipositor lobes stouter and longer; eighth segment collar a little longer; anterior apophyses a little longer than eighth segment collar; posterior apophyses over one and a half times as long as that collar.

Holotype: Male, Paducah, State owned Matador Wildlife Management Area, Cottle Co., Texas, 8 Sept. 1966 collected by A. & M. E. Blanchard; genitalia on slide A. B. 505; deposited in National Museum of Natural History (No. 73432).

Paratypes: All taken at Paducah, Cottle Co., Texas: 8 Sept. 1966, 1 ♀; 22 Sept. 1968, 1 ♂, 4 ♀ collected by A. & M. E. Blanchard; 23 and 24 Sept. 1968, 3 ♂ collected by D. F. Hardwick, in Canadian National Collection.

Copablepharon gillaspyi A. Blanchard, new species

Figs. 4, 7, 8, 12, 16

Head, collar, thorax, tegulae beige (light grayish, yellowish brown) (Fig. 4). Male and female antennae whitish above and structurally similar to those of *C. serraticornis*. Forewings above pruinose beige with a paler whitish, poorly defined fascia along costa extending almost to apex and a grayish streak along cubitus, fringes whitish. Hindwings above concolorous with costal fascia of forewings, paler basally; fringes whitish. Beneath, same color as above attenuated to nearly white. Wing expanse = 39–44 mm.

Male genitalia (Figs. 7, 8, 12): Similar to those of *C. serraticornis*, differing mainly in that the clasper is wider at its base and that the corona (Fig. 12) has over 30 spines crowded in 2–4 rows along distal margin of valve. Aedeagus similar to that of *C. serraticornis* (Fig. 8).

Female genitalia (Fig. 16): Similar to those of *C. serraticornis*, differing mainly in

that the setae on the ovipositor lobes are smaller and cover only the tip of the lobes and that the anterior apophyses are only three fourths as long as the eighth segment collar and the posterior apophyses barely longer than this collar.

Holotype: Male, Padre Island National Seashore, Kleberg Co., Texas, 28 Sept. 1973, genitalia on slide A. B. 3245, Dr. J. E. Gillaspys collector; deposited in the National Museum of Natural History (No. 73433).

Paratypes: Padre Island National Seashore, Kleberg Co., Texas, 28 Sept. 1973, 2 ♂; 7 Oct. 1974, 3 ♂, 1 ♀; J. E. Gillaspys collector. Same location, 29 Sept. 1975, 1 ♂; North Padre Island, Nueces Co., Texas, 30 Sept. 1975, 1 ♂; A. & M. E. Blanchard collectors.

I take pleasure in naming this species for its discoverer, my friend, Dr. J. E. Gillaspys, Professor of Biology at A. & I. College, Kingsville, Texas.

C. serraticornis and *C. gillaspys* are both closely related to *C. serrata* McDunnough, but the antennae of *C. serrata* are not as strongly serrated, their serrations are scarcely more than sharp bulges to the sides; the widest portion of a segment is usually about 1.5 times as wide as the narrow portion, the male valves of *C. serrata* are angled near the apex as those of *C. albisericea* and not evenly convex as those of the other two species.

ACKNOWLEDGMENTS

I am deeply grateful to Mr. J. D. LaFontaine of the Biosystematics Research Institute, Agriculture Canada, for providing me with all the information I needed about all the other previously described taxa in this genus, for many invaluable suggestions and for revising the manuscript.

NATHALIS IOLE (PIERIDAE) IN THE SOUTHEASTERN
UNITED STATES AND THE BAHAMAS

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In the *Lepidoptera of Florida* Kimball (1965: 36) devotes most of his brief discussion of *Nathalis iole* Boisduval 1836 to an unusual subject: the absence of early records of it from the state. He concludes, "Perhaps the species began to establish itself during the late 1920's," and adds that a search should be made in collections for pre-1930 records of *iole* from Florida.

Kimball based his contention chiefly on two points. First, Grossbeck (1917, see below) cited only a single Florida record of *iole*. Second, the late W. T. M. Forbes examined the collection of Harvard's Museum of Comparative Zoology and reported (*in litt.* to Kimball) that it contained no *iole* earlier than a 1924 Coconut Grove specimen that "looks suspicious" and an authentic series dated 1933-1934.

A survey of the Carnegie Museum Collection, which contains much old Florida material, shows that our oldest Florida specimens of *iole* are: a male from Dunedin [Pinellas Co.], 3 April 1921, *leg.* W. S. Blatchley, and two from Miami [Dade Co.], October 1921, *leg.* J. Harold Matteson. It is noteworthy that the W. H. Edwards Collection has none, although he received many butterflies from Dr. William Wittfeld, who lived and collected at Georgiana [Brevard Co.], on the Indian River, in the 1880's; nor are there any taken by G. Krautwurm, who collected extensively for the museum at Lutz [Hillsborough Co.] and nearby Stemper, notably in 1911.

In the American Museum of Natural History are the following pre-1930 records of *iole*: a male from Jupiter [Palm Beach Co.], 1-24 February 1920, *leg.* W. C. Wood; a male from Ft. Myers [Lee Co.], 22 April 1922, *leg.* F. M. Jones; two females, Punta Gorda [Charlotte Co.], 18-19 April 1922; and a female from Homestead [Dade Co.], 18 April 1923.

The older literature provides further interesting information. Scudder (1889: 1842) says of *iole*, "... not known in even southernmost Florida"; and farther on, "... does not appear to occur in the United States anywhere east of Louisiana, although it is found in Cuba and Jamaica." Skinner (1898: 63) gives the distribution of *iole* as "Ill., Mo. to Cal., N. Mex., Ariz., Tex., Mex. . . ." and his supplement ([1905]: 22) adds no further distributional data. Dyar (1901: 449) makes no mention of *iole*

in a list of winter (January and February) Lepidoptera taken near Lake Worth [Palm Beach Co.] in 1890 and 1900.

The earliest notice of Florida *iole* that I can find is the one Kimball mentions, Grossbeck (1917: 9), who gives a single record, "Big Pine Key, Sept. 20 (Ds.)." This specimen was taken by William T. Davis—"Ds."—in 1913, and is conserved in the Staten Island Institute.

Published evidence and that in available collections, therefore, support Kimball's basic contention completely. The fairly extensive information is all consistent with an hypothesis that *Nathalis iole* was formerly absent from Florida, and that it invaded the southern part of the state, probably from Cuba, sometime before 1913. (Davis's capture in the lower Florida keys could have been within a year or two of its first landfall and close to the original site.) It established itself and gradually extended its range northward. By 1920 it had reached Jupiter on the east coast, by 1921 the Tampa area (Dunedin) on the west coast, and in 1931 it was found in Atlanta, Georgia (Harris [1950]; 1972), about its present northern limit. If these dates are used, *iole* spread northward at an average rate of about 42 miles per year, possibly somewhat slower at first, faster later on. An important point (commented on by Klots, 1951) is that *iole* in the eastern part of its range is confined to the southernmost states (central Georgia southward). In the Mississippi Basin (see below) it ranges far to the north of this latitude.

Nathalis iole may also be a relative newcomer in the Bahamas. The species is now known from four islands, all in the northern part of the archipelago: Grand Bahama (Rindge, 1955); New Providence (West, 1966); North Bimini (Rindge, 1952) and North Andros (Nicolls Town, June 1973, *leg.* Clench; unpublished).

In the present connection New Providence is the most instructive because it is by far the most thoroughly collected island in the Bahamas, and collections from there date back to the 1880's at least. Charles J. Maynard made a large collection there in June 1897, conserved in the Museum of Comparative Zoology. *Nathalis iole* is not represented. J. L. Bonhote collected extensively on New Providence in 1898; his specimens are now in the British Museum. Sharpe (1900) published an account of them, but *N. iole* is not mentioned. W. W. Worthington collected a large lot of Bahama butterflies for Carnegie Museum in 1909–1910. He visited many islands and was on New Providence in January 1909. He took no *Nathalis iole*. The American Museum Collection contains New Providence material taken by various collectors in 1912, 1915, 1929 and 1930 (reported in Rindge, 1952). No *Nathalis iole* is represented in this material, but these collections appear not to have

been extensive so no particular significance can be attached to the absence of *iole* from them. The first known captures of *iole* on New Providence were the specimens taken by West in 1945, which he reported in 1966. Interestingly, *iole* is also represented in a small collection made on New Providence for Carnegie Museum in 1946.

In sum, *N. iole* was probably absent from New Providence in 1897 and 1898 and could have been absent as late as 1930; but it was present in 1945.

Nearly all species of Bahama butterflies have reached the islands from Hispaniola, Cuba or Florida. For the most part, each of these source areas generates a different, characteristic, pattern of distribution within the Bahamas, and most species from that source tend to follow the pattern. Unfortunately, the known distribution of *iole* is ambiguous. It is restricted to the northern islands, a pattern characteristic of invaders from Florida; but it also includes Andros. Invasion from Cuba to Andros to New Providence and other northern islands is both reasonable and in part substantiated by the ranges of other species.

At present all we can say about the arrival of *Nathalis iole* in the Bahamas is that it probably reached the islands sometime between 1898 and 1945. The chances are that it came in the period 1920–1940, but this is by no means certain. It may have arrived from Florida, where *iole* was by then established, or it could have come in directly from Cuba.

Now back to the mainland. *Nathalis iole* is divisible into three different geographical components which, for want of a better term, may be called *segregates*. At present, the chief discriminating attribute of these segregates is the northward limit of their ranges. This seems a slender thread on which to hang such a speculation, but two further points prompt me to suggest it: (1) the varied northward limits of their distributions suggest physiological differences in their tolerance to cold and a possible further difference in their migratory tendencies; and (2) each of the three segregates is associated with a different southern part of the species range. The three segregates are as follows:

1. *Southeastern*. In the United States this segregate is confined to Florida and southern Georgia, with no evidence of repetitive northward migration. It is probably not cold tolerant. As detailed above, this segregate is a probable recent arrival in the United States from Cuba. The southern limits of its range include the northern Bahamas (where it is also a probable recent arrival), Cuba, Jamaica and possibly Hispaniola (Brown & Heineman, 1972: 62 [“?” in table]).

2. *Central*. In America north of Mexico this segregate extends from

Mississippi to Arizona, and far northward to Ontario, Manitoba, North Dakota, southeastern Wyoming, nearly all of Utah, and perhaps as far west as the eastern slopes of the Sierra Nevada in California (Warren Creek, 9000–9500 ft., ca. 5 mi. W Lee Vining, Mono Co.: Garth & Tilden, 1963: 88). Whether it is resident northward or occurs there only as a result of repeated immigration is not known, but most authors believe that the latter is the correct explanation. This segregate can tolerate temperatures below freezing and has been found flying at Colorado Springs as late as early December (Brown *et al.*, 1956: 200; Brown, *in litt.*). Regardless of the nature of its northward occurrence, it differs conspicuously from the Southeastern segregate in being there at all. The southern limits of the range of this segregate include Guatemala (1 ♂, Carnegie Museum) and Mexico, where it is resident to altitudes of at least 7000 ft. (2150 m). The range appears to be old and probably has not changed significantly in historic times. Early authors did not mention it as occurring much north of the latitude of Illinois, but areas north of there were then poorly collected and in these areas *iole* is sporadic and generally uncommon.

3. *Pacific*. In the United States this segregate is confined to southern California (Emmel & Emmel, 1973: 22). The northernmost record that has come to my attention is Kennedy Meadows, Tulare Co. (anonymous reviewer), unless the Warren Creek record mentioned above should belong here. The occurrence of this segregate in California is spotty but it is locally common (as is true, *inter alia*, in Florida and the Bahamas), but nothing in its known range suggests that it is cold tolerant. Emmel & Emmel (*loc. cit.*) mention it as being found “occasionally . . . [at] high elevations in the mountains, especially in late summer,” so this segregate may have a limited tendency to migrate. Southward the range includes the whole of Baja California.

In summary, then, the Southeastern segregate does not range northward, is non-migratory and its southern limits are in the West Indies; the Central segregate ranges far northward, is probably migratory and its southern limits are in mainland Mexico and Guatemala; and the Pacific segregate does not range far northward, may be slightly migratory and its southern limit is in the peninsula of Baja California.

At present the United States portions of the ranges of the three segregates appear to be slightly disjunct. Whether or not *iole* occurs in Alabama (where the Southeastern and Central segregates might meet) or in western Arizona (where the Central and Pacific segregates could be in contact) is of little moment in establishing the thesis of three segregates.

It would be satisfying to be able to delineate their common boundaries (if they are indeed in contact) more precisely, but even with records from the intervening areas it would be no easy task. Despite careful comparison, the only difference among these segregates that I have been able to find in museum specimens is that in the Central segregate the hind wing upperside of the winter form female is usually yellow, less often pale orange; whereas at least in the Southeastern segregate, females of the winter form are as strongly orange as those of the summer form. In material available to me, adequate dated specimens of the winter forms of all three segregates are few, however, and even this difference is not certain.

Curiously, both the slight facies difference and the possible physiological differences seem to concern only the Central segregate. No evidence as yet would indicate any real intrinsic difference between the Southeastern and the Pacific segregates, even though they are widely separated geographically and the Central segregate intervenes.

ACKNOWLEDGMENTS

I am grateful to the following for their help in providing information on specimens in their care: Dr. Frederick H. Rindge, American Museum of Natural History, New York; Dr. George O. Pratt, Jr., director, and Mr. Joseph Burke, Staten Island Institute of Arts and Sciences, Staten Island, New York. I also thank an anonymous reviewer of an earlier version of this paper. He provided a northern locality record of *iole* in California and clarified the probable status of the Warren Creek record.

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MASS HIBERNATION SITE FOR *NYMPHALIS VAU-ALBUM* (NYMPHALIDAE)

Hibernation is common in several genera of butterflies and especially among Nymphalidae. However, in most cases the literature on such hibernating is rather nebulous and repetitive, without specific observational support. One takes for granted that hibernation spots are found beneath debris, loose bark, in hollow trees, etc. Therefore I was interested to see fourteen Compton tortoise shells (*Nymphalis vau-album* (Denis & Schiffermüller)) actually entering a hibernation site.

The observations took place near a radio relay tower at the summit of Mohawk Mountain, Mohawk State Forest, near Cornwall, Connecticut on 15 October 1974 between 1300-1400 hrs. EST. During this still, warm period my attention was drawn to several butterflies fluttering about near the top of the tower some 20-30' about the ground. Viewing them with my binoculars I made them out to be *N. vau-album*. Several also rested on the dark green screening of the building windows 6' above the ground. In each case there seemed to be a concentration at one common area. Watching the junction at the corner of the building and the roof, I could see the butterflies alight, then walk to an opening between metal stripping and the wall. The opening, approximately 2" long and $\frac{3}{4}$ " wide, was the focal spot for the butterflies. The butterflies approached this opening, folded their wings and disappeared within. Some would stay inside for a short time, then re-emerge, fly about in a circle, return and re-enter. According to C. L. Remington (pers. comm.), in Autumn, nymphalines change their phototactic responses and are attracted to dark areas. This opening provided such a spot, appearing black against the white walls.

The greatest number of individuals seen at any one time was fourteen, and all seemed to be using the opening.

Although some individuals were seen to enter and re-emerge, most stayed inside. Therefore, it is felt that this area was a definite hibernation spot for this species.

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OBSERVATIONS OF *EUPACKARDIA CALLETA* IN
SOUTHERN TEXAS (SATURNIIDAE)¹

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Eupackardia calleta (Westwood) is known to occur in southern Texas from the area of Victoria and Beeville south into the Rio Grande Valley and westward into the Big Bend Area (Collins & Weast, 1961; Ferguson, 1971-72). During the latter half of 1974, while temporarily assigned to Fort Sam Houston, San Antonio (Bexar County), I was able to make field observations and rear this interesting and little reported saturniid.

From 9 August-4 December, populations of *E. calleta* were studied at 13 locations in 7 southern Texas counties (Karnes, Goliad, Bee, Live Oak, McMullen, Jim Wells and Duval), primarily by observing immature stages on one of this species' known food plants, cenizo, *Leucophyllum frutescens* (Berland.).

Fifty-seven cocoons were collected from 9 August-28 September. These contained: 18 viable pupae (15 ♂; 3 ♀); 37 pupal cases (15 ♂; 15 ♀; 7 undetermined sex) from which the adults had emerged; 1 parasitized female pupa; and 1 dried, intact larva. All of these cocoons, with viable pupae or otherwise, had a very worn, smooth surface and it was not possible to use the appearance to estimate the cocoon age. Likewise, the age of the cocoon could not be estimated by determining whether or not the silken attachment had ligatured the stem of the food plant, since this condition was observed for some of the cocoons with viable pupae and some without. However, these observations of the appearance of the cocoon surface and the ligaturing of the food plant stems suggest that some of the cocoons with viable pupae were probably as old as some of those from which the adults had emerged.

The eighteen viable pupae were kept outdoors at San Antonio and the adults emerged in 1974 as follows: 14 Sept. (1 ♂); 15 Sept. (1 ♂); 17 Sept. (1 ♂); 18 Sept. (1 ♂); 24 Sept. (2 ♂, 1 ♀); 26 Sept. (2 ♂); 2 Oct. (1 ♂); 7 Oct. (2 ♂); 9 Nov. (1 ♂); 10 Oct. (1 ♀); 11 Oct. (1 ♂, 1 ♀); 13 Oct. (1 ♂); 29 Oct. (1 ♂). Although these pupae were removed from their original collection locations, it is probable that the period of emergence at San Antonio generally coincided with the period of natural

¹ The opinions contained herein are the private views of the author and should not be construed as official or reflecting the views of the Department of the Army.

emergence farther south, since, as noted later, naturally-occurring males were observed in Jim Wells and Live Oak counties on 28 September.

An additional 47 cocoons collected between 26 October and 29 November included 27 with viable pupae (15 ♂, 12 ♀). The 20 cocoons without viable pupae were not examined to determine the nature of the contents, but all had the same smooth, worn appearance mentioned earlier, indicating that they were not recently formed. The cocoons with viable pupae were of recent origin because they were white and powdery in appearance, and had short, loose silken threads on the surface or silken networks still attached to various parts of the food plant. Observations of the larvae reared at San Antonio during 1974 showed that they spin a silken network upon which they construct the typical teardrop-shaped cocoon. After the cocoon has taken form, the larva secretes a white fluid which, upon drying, imparts the powdery appearance. The silken threads and the powdery appearance evidently disappear with weathering and their presence is a reliable indicator of recent formation.

Several naturally occurring adult males of *E. calleta* were observed in two instances in southern Texas. The first instance relates to the female that emerged at San Antonio on 24 September. This female was transported to Live Oak Co. on 28 September and set out at 0845 CST. Seven males were attracted from the surrounding cenizo fields within 5 minutes. The eggs from this mated female were used to colonize this species at San Antonio. This method of survey for adult males would have been used more extensively if there had been more females among the viable pupae collected up to 28 September. The second instance was in Jim Wells Co. on 28 September where binoculars were used to observe males flying over the extensive cenizo fields that occur along U.S. Highway 281. The straight-line flights of 3 males were observed for some time in the hope that the moths would pause, circle, or drop into the vegetation and possibly indicate the presence of a naturally occurring female. No such behavior was observed, and the males eventually flew out of sight.

Since no observations were made between 28 September and 16 November, the dates of occurrence of early instar larvae were not determined. However, 4th- and 5th-instar larvae were observed in Goliad and Bee counties between 16 November and 4 December. Larvae observed on 16 and 29 November were inactive, with only a few feeding or spinning cocoons. This was probably due to the cool temperatures (6-7° C) prevailing at the time. The last observations in Goliad and Bee counties were made on 4 December. At that time a few more cocoons had been formed, but most of the larvae were still inactive and

not feeding. Eighteen 5th-instar larvae were collected on 4 December and transported to San Antonio where they were kept on cenizo cuttings. Some of these larvae began spinning in transit; all had spun cocoons by 7 December. The fact that these larvae began spinning within hours after being placed in a warm environment suggests that they might have remained inactive on the plants in Goliad and Bee counties (as they had from 16 November–4 December) until the return of warm weather in early spring. Unfortunately, follow-up observations of these natural populations could not be made.

Although the foregoing observations provide specific records of the occurrence of *E. calleta* life stages in southern Texas, they are from scattered areas and chronologically incomplete. As such, they provide only limited insight into some aspects of the biology of this species. One interesting observation is that certain of the cocoons, with or without viable pupae, were very similar in surface appearance; and that cocoons of both types had ligatured the food plant stems. This suggests that for individuals of a single generation there is considerable variation in the time period between cocoon formation and adult emergence. In this regard, Kendall (1974) has observed that some *E. calleta* pupae remain in diapause for up to 22 months. Thus it is understandable that confusion exists concerning generations represented by the reported annual bimodal emergence (March and September–November) of *E. calleta* in southern Texas. Collins & Weast (1961) reported that *E. calleta* emerges in southern Texas from late October through November, with a partial second emergence occurring the following March. Ferguson (1971–72) reported that there is a partial emergence of *E. calleta* in March in southern Texas, followed by a larger emergence which takes place from September–November. Although these authors do not specifically refer to these emergences as generations, this is alluded to in later statements concerning the fact that *E. calleta* is known to emerge in Arizona only in August, and that there may be only one generation of this species in Arizona. Annual bimodal emergences are known for other saturniids, such as *Hyalophora cecropia* (Linnaeus). In Illinois, *H. cecropia* has two distinct periods of emergence which are very close together (May–early June and late June–July). However, these two periods of emergence are known from an intensive 3-year study by Sternburg & Waldbauer (1969) to represent a single generation. In the case of *E. calleta*, the March and September–November emergences may represent individuals from two or even three earlier generations, but this situation requires considerably more detailed study to be understood. The observation that larvae remain inactive on the food

plants during cool periods in late November and December could represent a mechanism whereby the development of individuals from a single generation becomes out of phase; with the adults eventually emerging during one or the other of the annual bimodal periods. Certainly, there was considerable variation in the progress of development among individuals that might be considered to represent a "fall" generation; some had formed cocoons and pupated as early as 16 November in Karnes Co.; others were still in the 4th instar as late as 29 November in Bee Co.

ACKNOWLEDGMENTS

I wish to thank Roy O. Kendall, of San Antonio, for sharing his records and knowledge of this saturniid species and for taking the time to review this paper; and to thank Captains Alan R. Gillogly and Rowland N. Wilkinson, formerly of Fort Sam Houston, who accompanied me on some of the field trips to southern Texas.

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EMERGENCE OF *HYALOPHORA CECROPIA* (SATURNIIDAE) BLOCKED BY SEEDS IN THE COCOON VALVE

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In the fall of 1974 we collected in Champaign, Illinois, a cocoon of *Hyalophora cecropia* (L.) that, unknown to us, had the exit valve blocked by three unshelled sunflower seeds and half of a peanut kernel which had presumably been inserted there by a bird. At that time the cocoon was heavy and, when shaken, felt as if it contained a living pupa. It was chilled to break diapause and then placed in an incubator at 25°C with other cocoons. When it became obvious that nothing would emerge from this cocoon, we cut it open and discovered the seeds and a dead adult female that apparently had been unable to push through the blocked valve. We have found many cocoons with foreign objects, usually seeds, forced into the exit valve, but this is the first time we have seen direct evidence that this can result in mortality.

Reports of seeds within the valves of *cecropia* cocoons are scattered throughout the literature. For example, Minot (1870) found beech nuts, and LeBaron (1870) and anonymous (1870) found corn kernels. Waldbauer & Sternburg (1967) found a variety of seeds and an earthworm.

Every fall and winter since 1965, we have found foreign objects in *cecropia* cocoons collected in or near Champaign and Urbana, Illinois, but we recorded data only during the first three years. The number and percentage of cocoons with foreign objects found each year are: 1965-66, 15 (3.1%); 1966-67, 7 (3.5%); and 1967-68, 32 (2.9%). Twenty-two of these cocoons contained living pupae, one contained a dead larva, and 31 had pupae that had been killed by a woodpecker (Waldbauer & Sternburg, 1970). Forty-one cocoons contained one foreign object, eight contained two, four contained three, and one contained four. The 54 cocoons contained 75 different objects: 26 unshelled sunflower seeds, 21 corn kernels, 11 unidentified pieces of nut meat, eight shelled sunflower seeds, two half peanut kernels, two whole acorns, two pieces of shelled acorn, one entire peanut kernel, one piece of Brazil nut, and one dead earthworm. All of these cocoons were in exposed positions on a twig or branch. One was on the branch of a shrub (*Cornus stolonifera*) at a height of 1.2 m. The rest were on the twigs or branches of trees—mostly *Acer saccharinum*, *Betula* spp., or *Malus* spp.—at an average height of approximately 2.38 m above the ground (range: 0.3 to 6.1 m).

With one exception, the objects were pushed through the valve of

the outer envelope into the space between the outer and inner envelopes [see Waldbauer & Sternburg (1967) for illustration]. The exception was a corn kernel pushed through a hole in the outer envelope at the end opposite the valve.

Several birds that occur in this vicinity are reported to insert seeds in crevices, knot holes, and other crannies: the bluejay (Bent, 1946), the white-breasted nuthatch (Bent, 1948), and the red-bellied and red-headed woodpeckers (Bent, 1939). However, only the bluejay is common in the urban environment in which we collected most of the cocoons.

We do not know how frequently blockage of the valve is sufficient to prevent the escape of the adult from the cocoon because we removed any foreign objects we noticed. A seed or two in a cocoon may have escaped our notice. Indeed, we often found sunflower seeds and corn kernels, apparently pushed out of the valve by emerging adults, at the bottom of our emergence cages. However, a blockage large enough to prevent the moth's exit has obviously escaped our notice only once. Eleven of the 54 cocoons mentioned above appeared to be sufficiently blocked to prevent emergence, but we do not know if this would have happened, either because we removed the objects or because the cocoon did not contain a living pupa.

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DESCRIPTIONS OF THE IMMATURE STAGES AND BIOLOGY
OF *VITULA LUGUBRELLA* (RAGONOT)
(PYRALIDAE: PHYCITINAE)¹

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Vitula lugubrella was described by Ragonot in 1887. In 1901, Hampson, who completed volume 8 of Ragonot's "Mémoires sur le Lépidoptères", included a slightly more extensive description [based in part on *Moodna ostrinella* (Clemens)] and a figure of the adult of this phycitine. Heinrich in 1956 described and partially illustrated the male genitalia.

The present paper gives information on the appearance of the last stage larva, pupa and habits of the larval stage.

Last Stage Larva

Color.² Head yellowish brown; all groups of muscle attachments usually pale brown, indistinct; small brown patch at notch of postgenal region of head, with darker pigmentation extending dorsally along posterior margin of head capsule; hypostoma with brown to black markings; mandibles yellowish brown between articulations becoming dark brown to black distally and dark brown to black along lateral margins.

Prothoracic shield yellowish brown to brown without any distinctly contrasting patches of color.

Prespiracular plate yellowish brown to brown.

Remainder of prothorax yellowish white, white or grayish white (translucent pink to pinkish white in living larva).

Mesothorax and metathorax yellowish white, white or grayish white (living larva translucent pink to pinkish white; young last stage larva with internal organs readily evident, including dark purple gut and pale, whitish tracheae); mesothoracic ring pale brown to dark brown, usually darker along inner margin.

Thoracic legs mostly yellowish brown.

Abdomen similar to mesothorax and metathorax; caudal segments usually more yellowish (living larva with pink and dark internal color not as evident on caudal segments).

Eighth abdominal segment ring pale brown to brown, usually paler than mesothoracic ring.

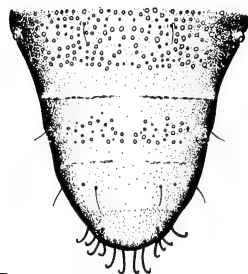
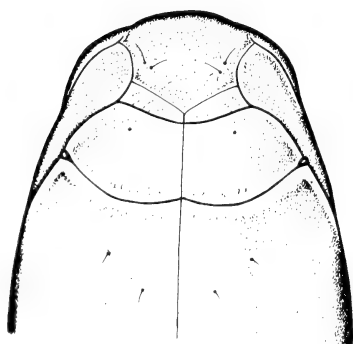
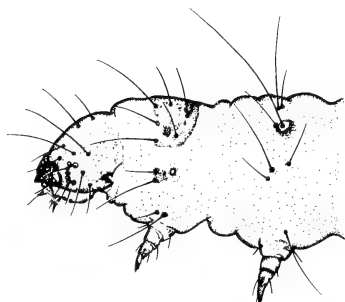
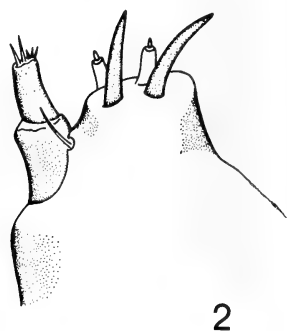
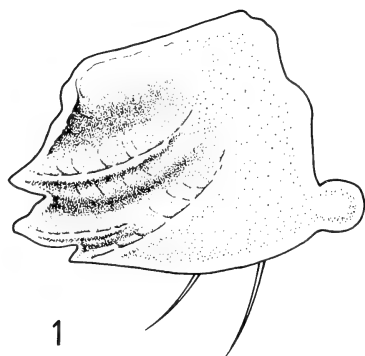
Anal shield pale translucent yellowish brown, without distinct markings.

Peritreme of spiracles pale brown to brown.

Structural characters. Entire length 12.5–18.5 mm. Width of head 1.19–1.32 mm. Mandibles (Fig. 1) with 3 distal teeth. Sensilla styloconica of maxillae (Fig. 2) simple, tapering to a point, curved mesally.

¹ Paper No. 4769 of the Journal Series of the North Carolina Agricultural Experiment station, Raleigh.

² Of preserved larva, unless otherwise indicated.



Figs. 1-5. *Vitula lugubrella*. 1, mesal view of right mandible of last stage larva; 2, mesal view of left maxilla of last stage larva; 3, lateral view of head, prothorax and mesothorax of last stage larva; 4, dorsal view of cephalic segments of pupa; 5, dorsal view of caudal segments of pupa.

Most morphological characters similar to *Vitula edmandsae* (Packard), as described and figured by MacKay (1972), with at least the following exceptions:

On the head, L1 distinctly above imaginary line between A2 and A3 (Fig. 3) (*V. edmandsae* with L1 very close to, or on, an imaginary line between A2 and A3); prothoracic shield with distance between XD2 and SD1 only slightly less than distance between SD1 and SD2 (Fig. 3) (*V. edmandsae* with distance between XD2 and SD1 distinctly less than between SD1 and SD2); abdominal segments 1-5 with D2 setae about $2\times$ longer than D1 setae (*V. edmandsae* with D2 setae on 1-5 about $3\times$ longer than D1 setae).

Pupa

Color. Yellowish brown to brown.

Structural characters. Length (excluding cremastral "spines") 8.3-10.0 mm. Width across mesothorax 2.4-2.6 mm.

Head minutely granulate on front; vertex broadly produced anterior to prothorax (Fig. 4).

Thoracic spiracles distinct, narrow, protruding (Fig. 4) dorsum of metathorax with 2 groups of about 16 shallow punctures.

Cephalic $\frac{1}{2}$ to $\frac{2}{3}$ of abdominal segments 1-3 with numerous shallow punctures; punctures usually do not reach spiracles on segment 2 and barely extend to spiracles on segment 3; segments 4-7 with numerous shallow punctures encircling segments; segment 8 with 2 groups of dorsal punctures and D1 and L2 setae (D1 missing on some specimens); segment 9 with D1, L2, and L3 setae and sometimes vestigial SV2 setae; segment 10 with 12 stout, hooked setae (Fig. 5); gibba absent.

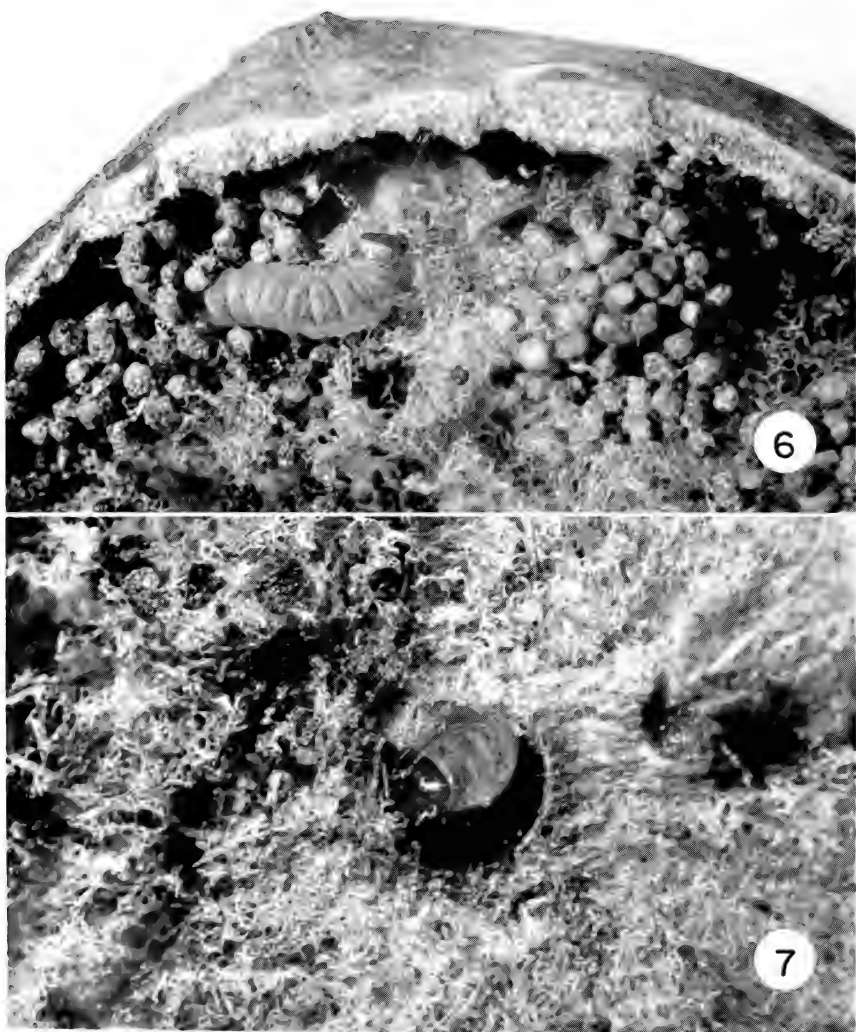
Material Examined

TEXAS: Ft. Davis, 8 larvae, 1 pupa, *Quercus grisea*, Liebmann 9-IX-73, Coll. H. H. Neunzig; 3 larvae, *Quercus grisea*, Liebmann 28-IV-74, Coll. H. H. Neunzig; 5 larvae, 2 pupae, *Quercus grisea*, Liebmann 27-IV-75, Coll. H. H. Neunzig.

Larval Habits

Larvae of *Vitula lugubrella* live within the dried galls of *Atrusca* spp. which occur on *Quercus grisea*. These cynipid galls are of the "oak apple" type and are approximately 15-30 mm in diameter. The small larvae feed just inside the outer covering of the gall on the fibrous material that constitutes most of the internal structure (Fig. 6). Late or last stage larvae also feed on these peripheral fibers and, in addition, frequently tunnel through the center of the gall, including the central chamber in which the cynipid develops (Fig. 7). Large quantities of conspicuous, loose frass accumulate within infested galls. Pupation takes place in a loosely woven silk cocoon within the gall. *Vitula lugubrella* apparently is multivoltine because larvae, of various sizes, and pupae, at different stages of development, are present in galls in the spring and also in the fall.

Vitula lugubrella is the 2nd North American phycitine species known to be associated with "oak apple" galls. *Sosipatra thurberiae* (Dyar)



Figs. 6-7. *Vitula lugubrella*. 6, partially grown larva in gall of *Atrusca* sp.; some of the frass in the gall was deposited by a large larva of *V. lugubrella* that inhabited the gall earlier; 7, last stage larva in tunnel made through center of gall of *Atrusca* sp.

has previously been reported by Heinrich (1956) as an inhabitant of these leaf galls. It is interesting to note that Roesler (1973) has synonymized *Sosipatra* and *Vitula* indicating a close relationship between *lugubrella* and *thurberiae*.

ACKNOWLEDGMENT

The drawings were prepared by Mrs. Lily Shen.

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SUMMER MONARCH (*DANAUS PLEXIPPUS*) IN SOUTHERN TEXAS
(DANAIDAE)

The monarch, *Danaus plexippus* (L.), is by far the best-known butterfly in North America. During several years' personal observation in the Brownsville, Cameron Co. area of southern Texas, monarchs were normally observed only from late September through April. Adults were most commonly seen in the fall and early spring as they migrated south and north, respectively. However, in warmer years monarchs were observed during the winter months. Other observers (see Urquhart 1960, The Monarch Butterfly, U. Toronto Press, pp. 165, 172-173; Yeager 1974, News Lep. Soc. 1974(3), p. 3) have reported similar near total absences of monarchs in southern Texas during summer months. Summer breeding of monarchs is normally limited to northern Texas and areas to the north.

However, in June and July 1966 larvae of the monarch were found in Brownsville on milkweed. Adult monarchs reared from wild larvae in the laboratory emerged on 17 June (2), 19 June (4), 3 July (1), 5 July (1) and 11 July (2). Climatic factors could have been involved in this southern extension of summer breeding of the monarch in 1966. Temperatures during January-May were cooler than normal. January was wetter than normal followed by three months of very little rainfall (2.16 in.) until a very wet May (6.05 in. vs. normal 2.50).

Another possible factor needs to be considered. The monarch butterfly is subject to cyclical population crashes which have attributed to a cytoplasmic polyhedrosis virus (Urquhart 1970, Atalanta 3(2): 1-11). The year 1966 was characterized by generally low populations throughout most of North America, including southern Texas (Urquhart 1970, op. cit.). If the monarch is less prone to migrate during low population periods as suggested by Urquhart (1970, op. cit.), this aberrant summer occurrence of the monarch in the Brownsville area may have been the indirect result of a virus outbreak.

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BOOK REVIEWS

THE BUTTERFLIES OF NORTH AMERICA, by William H. Howe, Contributing Editor. 1975. Doubleday and Co., Inc., Garden City, L. I. New York. xiii + 633 p. +97 plates. Price \$39.95 U.S. for the standard edition.

This long awaited work, including sections by twenty contributors, edited and illustrated by Howe, fails to meet expectations. Some sections are very well done while others are not. These will be treated in specific terms subsequently. The general format of the book follows that of Holland's *Butterfly Book*, including the general introduction and the sequence of presentation of families. The family sequence is awkward in comparison with modern books and checklists. The work begins with the danaids and ends with the Hesperioidea. The colored plates are bound in the middle of the volume. Also included are a glossary of terms, a short bibliography and general index plus an index of food plants.

General criticisms of the book relate to nomenclature, literature citations, the plates and ease of use. It must be recognized that considerable time may elapse between the date when the finished manuscript is submitted to the publisher and the release of the bound volume. On this basis, the author can be forgiven for not including taxonomic work published after late 1973. On the other hand, much work in some families prior to that date is omitted, while in other families it is included. There is a basic lack of consistency in this respect. It probably relates to the fact that the various contributors submitted their entries over a wide time period, however it is the job of the editor to note additional work and insure that the contributors make any necessary changes. Apparently the individual authors saw neither the final manuscript nor the galley proofs. It also appears that the plates were executed without consultation with the authors and prior to the writing of many of the sections. The authors should have been given the opportunity to select the specimens illustrated.

Despite an initial statement to the contrary on p. vii, a number of new taxa are introduced (which may cause problems with authority) and other taxa are omitted without comment. There is considerable lumping of subspecies in some genera without appropriate discussion. There is no reference for the new Bauer names in the Melitaeinae, for example, and one assumes that the book constitutes the first publication of these taxa. With respect to the Code of the I.C.Z.N. (Arts. 11, 13, 68-73), some or all of these names *may* represent *nomina nuda*. No holotypes have been designated; in most instances no type localities are indicated; in several cases the accompanying text does not clearly distinguish how the new subspecies differs from the related subspecies. Other problems in the text include incorrect and incomplete distribution information, incorrect and incomplete flight periods, and too many typographical errors. The first two categories could have been avoided by checking original descriptions of many of the species and available regional books and checklists, as well as the "Annual Summary" in the *News of The Lepidopterists' Society*.

Although a bibliography appears at the end of the book, I question the rationale of its selection. A number of pertinent entries are omitted, while others of lesser value are included. Author and date citations included in the main text do not appear in the bibliography in many cases.

Regarding ease of use, I find it awkward to have the plates bound in the middle of such a large volume. A more critical feature is the lack of page references in the plate legends, although the text descriptions cite plate and figure.

The color quality of the plates requires some comment. Watercolors can come close to modern photography, and there are some practical book production problems that favor their use, but they definitely detract from the scientific value

of this book. There is a distinct color shift to green and blue-green in many of the plates. This is especially noticed in the Hesperioidea where the warm browns are gray-green-brown and in the lycaenids where many of the colors are off-register. Part of this relates to poor quality control in the printing. I had occasion to check several copies of the book. On given plates, the colors were not uniform throughout the copies. A number of plates have a pastel color background, usually green or blue, so that better definition is given to the specimens represented. The intensity of the background varied considerably from copy to copy, with concomitant color shifts in the specimens depicted. This situation was prominent in three copies examined, although not the same plates were involved. Based upon comments from correspondents who have seen other copies of the book, some do not exhibit this problem to the extent that the copies I examined did. The unrealistic blue and red tones throughout the book, however, appear to stem from the original plates. While scientific illustrators may take "artist's license" to insure reasonable reproduction of their subjects in the final printed form, Howe has overdone this technique in many cases, producing an artificial and unrealistic portrayal. Many of the plates have a "washed out" aspect, which again may result from production difficulties, but this should not occur in a book of this scope. Generally, the colors are disappointing. The lycaenids, in many cases, should have been illustrated larger than life size. In many of the blues, it is difficult to tell just what is being represented in the figures.

Other problems relate to the mixing of families, genera and species over a number of plates. In some plates, examples from as many as six different families appear, when there is no valid reason for doing so. Another problem is the figuring of the male, female and underside of a given species over three separate plates. Initially some thought should have been given to the arrangement of the sexes and species so that the reader would not have to leaf through several plates to find all the illustrations for a given insect. The species corresponding to a given genus should have been uniformly grouped. One wonders why Figure 32 which illustrates maculation in *Parnassius* was placed on p. 211 in the *Speyeria* discussion.

On pp. 578-579, several addenda regarding distribution and taxonomy appear noting recent work. If some addenda could be included, why not all of the new works? It would have made the book both current and of more value.

Considering the magnitude and scope of this project, it seems strange that not a single genitalic sketch appears, excepting a generalized drawing in the introductory portion. In view of the, in many cases, marginal plates, especially in the blues and some of the Hesperioidea, genitalic sketches of the difficult species would have been very valuable. These would have been extremely useful in separating look-alike species in such genera as *Lerodea*, *Lerema*, *Nastra*, *Bolla*, *Cogia*, *Erynnis*, *Staphylos* and *Thorybes*. This is also true in several other families and genera such as *Euphydryas*, *Philotes*, *Oeneis*, etc.

In a number of instances, it was noted that the subspecies figured in a plate, with associated collection locality stated in the plate legend, did not agree with the text description of the distribution for that subspecies. The plates and associated text should have been carefully reviewed to prevent such inconsistencies. This situation is going to cause confusion and perpetuate misconceptions. There are also some misidentified species in the plates. These will be treated later.

On the positive side, the introductory material by Harry Clench (butterfly anatomy, biology, etc.) and Alexander Klots (scientific nomenclature, collecting, preserving, etc.) is extremely useful and informative to the amateur and professional alike. These are perhaps the best done sections in the book. The overall editing appears to have been carefully done to insure uniformity of format, a formidable task when twenty contributors are involved.

SATYRIDAE. The text appears basically correct, although I prefer the approach

that assigns most of the North American *Coenonympha* to *tullia* rather than the book approach which treats *inornata*, *ochracea*, *ampelos*, etc. as separate species. There are several recent revisions in the Satyridae that are not included. The concerned reader would do well to consult L. D. Miller's revisions in the Euptychiini published in the Allyn Museum Bulletin series. The Heitzman and dos Passos revision of *Lethe* should also be consulted (Trans. Amer. Entomol. Soc., 100: 52-99, 1974). *Erebia debanensis* is incorrectly identified as *E. youngi rileyi*, while discussion of *E. debanensis*, *inuitica* and *semo* is omitted. Incomplete distribution data are given for *Erebia callias*, *magdalena*, *Oeneis alberta daura* and *Gyrocheilus patrobas tritonius*. The latter is quite common in New Mexico in Grant and Sierra Counties. Records have appeared in published regional lists and in the Lep. Soc. News. Incomplete and incorrect data are given for *Oeneis jutta reducta* which was described from Montana and is found in eight Wyoming counties in addition to Colorado. The discussions of *Cercyonis meadii mexicana* and nominate *meadii* seem to be juxtaposed to some extent. It should be noted that the flight period for *Paramacera allyni* Miller (not *xicaque* which is Mexican) is normally from mid-July into early August, and not late summer as stated. The following errors were noted in the plates: Pl. 4, f. 22, *Coenonympha ochracea brenda* was described from the "Los Angeles area", although Brown in his discussion of the Edwards' types casts doubt upon this locality, suggesting the Great Basin. The Utah collection site is slightly odd, although I have taken *brenda* phenotypes in extreme western Nevada; Pl. 5, f. 1, the specimen shown is *Erebia rossii gabrieli* and not *E. r. kuskoquima* (note collection site and text discussion of distribution); Pl. 5, f. 16 is *E. theano ethela* and not *demmia* (note collection site, *demmia* is found only in one area of southern Colorado); Pl. 5, f. 18-19, specimens shown are *Coenonympha ochracea subfusca* and not *C. o. furcae* (note collection site and compare with text and Pl. 4, f. 23-24); Pl. 9, f. 12 is *Oeneis bore/taygete* and not *O. melissa gibsoni*.

NYMPHALIDAE. A number of nomenclatural changes occur in this section, most without adequate comment. A number of new taxa are introduced and the inclusion of recent taxonomic work is not consistent. All of the *Asterocampa* taxa are treated as separate species. Two recently described subspecies of *Euphydryas chalcedona* are included in the text, while two earlier described subspecies of *E. editha*, *alebarkii* Ferris and *gunnisonensis* Brown are omitted, although there is reference to the occurrence of *E. editha* in Wyoming and Colorado. J. Scott's work in *Poladryas* is omitted. It is stated that *Nymphalis californica herri* is the Rocky Mountain race. This subspecies was described from the Buckhorn Mountains in Washington and is found in the Priest River area of Idaho. Specimens from southwestern New Mexico through Wyoming are typical *californica*. The character by which *Vanessa atalanta rubria* is separated from nominate *atalanta* is reversed; *rubria* exhibits a somewhat smaller subapical white bar rather than a larger bar.

The main problem with this section is the treatment of the genus *Speyeria*. I disagree entirely with the elevation of *nevadensis* and *electa* to species status, and with several other nomenclatural changes. This assignment totally ignores the work that Grey and Moeck have done in studying the distributions and color phases of western *Speyeria*. Additionally, *leto* and *adiaste* are also elevated to species status. There is perhaps sound basis for the latter, but considerable further study is necessary with respect to *leto*. I do not accept minor variations in larval stages as the basis for separation at the species level. The form *clio* in *S. mormonia eurynome* has been given subspecific status. I can see no basis whatsoever for this action. Unsilvered forms are typical in all *mormonia* populations. I have taken mixed pairs in copulo. The author seems to have ignored the Rocky Mountain populations of *atlantis* and *callippe* in his elevation of *nevadensis* and *electa* to species rank. The misconceptions are too numerous to detail here. Two other taxa are treated to provide resolutions to two long-standing problems. *S. zereene sordida* is treated as

an aberrant form of *bremnerii* and is probably correct. The introductory section in *Speyeria* alludes to the *pfoutsi* and *platina* problem, but the ensuing text does not resolve it. Skinner's type series for *S. zerene platina* was a mixture of several species, which led Gunder to describe *pfoutsi*. The taxon *pfoutsi* should be considered a synonym of *platina*. The new species *S. egleis toygabe* Howe merits some comment. The figure reference in the text (p. 237) is incorrect as the reader is directed to Plate 31, f. 13 rather than f. 14. Apparently only the holotype has been designated without a type series. This is unfortunate as there is no discussion concerning the variation of facies within this subspecies. What is shown as the holotype (Pl. 31, f. 14) resembles quite closely some of the pale disc specimens from the *egleis* cline found in the Pine Creek area of Elko Co., Nevada.

Several items were noted in the plates: Pl. 34, f. 1 is a very poor rendition of *Boloria eunomia ursadentis*. This subspecies is distinctly pale and yellow-brown. Regarding the related text discussion of this species, it should be noted that it has been found to date only at high altitude on the Beartooth Plateau as cited in the original description (J. Res. Lep. 9(4):243-248, 1970 [1971]). Northern Wyoming and southern Montana colonies of *eunomia* are closer to *dawsoni* than to any other subspecies. Pl. 34, f. 3, the specimen figured is typical low altitude *eunomia* nr. *dawsoni*; *nichollae* is very dark, almost melanic, and apparently occurs above tree-line only at the edges of snow fields. The colors are misleading in a number of *Boloria* figures.

LIBYTHEIDAE. There is considerable confusion in the text (p. 258) and in Pl. 47, f. 14-15. The description of *L. carinenta* applies to *L. bachmanii larvata* and vice versa. The plate figures depict *larvata* and not *carinenta*.

RIODINIDAE. *Celephelis* is combined into seven species which seems an improvement over McAlpine's recent splitting of the genus. Some nomenclatural changes are mentioned.

LYCAENIDAE. This section is generally well done. Several minor items are noted. The subspecies *minnehaha* is applied erroneously, as did Holland, to the montane Colorado population of *Plebejus shasta*. This situation was explained by the author in 1970 (Ent. News 81:203-207). Pl. 59, f. 17 does not fit at all the concept of *P. shasta comstocki*. The specimens shown as *Plebejus icarioides pembina* (Pl. 56, f. 27-28) are from a blend-zone region and are not representative of neotopo-typical western Montana specimens. The specimen shown in Pl. 50, f. 12 is *Incisalia polios obscurus* Ferris and Fisher and not nominate *polios*. The text omits this taxon, described in 1973. *Plebejus acmon spangelatus* is assigned incorrectly to *lupini* despite Goodpasture's genitalic studies and revision of *acmon* and *lupini* (J. Kan. Ent. Soc. 46:468-485, 1973). The genus *Phaedrotes* is incorrectly retained instead of *Glaucopsyche* as pointed out by Brown (J. Lepid. Soc. 25:240-246, 1971). There are several new combinations proposed in *Callophrys*. In *C. mitoura*, the brood form *smilacis* has been elevated without comment to subspecific status replacing *sweadneri*. In the discussion of *Ministrymon*, it is stated that *ines* is simply the fall brood of *leda*. This bears further study. I have taken *ines* in May along with *leda* in southwestern New Mexico and typical *leda* in the fall. John A. Legge, Jr. has taken both forms from the same mesquite tree in Baja California del Sur in December. The distribution for *Satyrrium liparops fletcheri* is listed as southern Manitoba only; it also occurs in Saskatchewan and North Dakota. *Vaga blackburni* is described as "... an abundant species on all of the Hawaiian Islands.", which contradicts the recent proposal for inclusion of this species under endangered status. Pl. 60, f. 3-4 figure *Lycaeides argyrognomon ricei* and not *anna*. Various nomenclatural changes in *Lycaena* are proposed. It is stated that *L. arota schellbachi* extends into southern Wyoming. I know of no valid records for the state. The *Everes amyntula/comyntas* confusion seems to have been fairly well resolved in this book. The interested reader should refer to the recent revisionary

work on the *Philotes* group by O. Shields and published in the Allyn Museum Bulletin series, as he has proposed some substantial nomenclatural changes as well as describing new subspecies.

PAPILIONIDAE. Again there are some minor items in the generally well done treatment of *Papilio*. In Pl. 62, f. 1, *P. troilus* as shown as *P. brevicauda*. In Pl. 63 which illustrates the *machaon* complex, none of the undersides of the species are shown. Unfortunately, the undersides are diagnostic in most cases for reliable species separation in this group.

The treatment of *Parnassius*, however, is particularly distressing. Granted that there has been too much "splitting" in this group, the authors of this section go too far in the opposite direction. The lumping of nearly all of the Rocky Mountain region *phoebus* under the umbrella *sayii* with the retention of a few questionable additional subspecies (*hermodur* for example, which is an altitudinal female form) is unrealistic. Even the Great Basin *rubina* (text misspells as *rubiana*) is lumped into *sayii*. It appears that the authors have recognized differences in facies when it suited them and ignored same when it did not. The discussions of *P. clodius altaurus*, *gallatinus* and *menetresii* are badly mixed up. Pl. 78, f. 18 illustrates *P. clodius altaurus* (yellow-orange spots) and not *menetresii* (red spots). One should consult McDunnough's paper relative to Bryk's treatment of the North American *Parnassius* (Can. Ent. 68:216-225, 1936). There has been considerable confusion in the taxonomy of *Parnassius* in the past and the present treatment serves only to further rather than clarify it.

PIERIDAE. This section, with a major contribution by A. B. Klots, appears to be the most carefully done in the book, and cites current research as of early 1973. Many of the problem areas in the *Colias* have been resolved, and the genus *Pieris*, noting Warren's work, is thoughtfully handled. The illustrations accompanying this section are perhaps more realistic than in some of the other families. Dr. Klots is to be complimented on his handling of the *Coliadinae*. The specimen shown in Pl. 72, f. 17 as *C. o. occidentalis* from Crook Co., Oregon is probably a local form of *C. alexandra* peculiar to that region. *Appias drusilla poeyi* is dropped without comment. The subspecies *mayi* has been applied to all northern populations of *Euchloe ausonides*. This is not correct, as true *mayi* is a very distinct insect, and specimens from many of the colonies in the far Northwest do not qualify. Many are closer to nominate *ausonides*. The name *andrewsi* has been retained under *ausonides* rather than placed with *hyantis* as Opler suggested in his revision of the genus.

HESPERIOIDEA. Although Freeman's 1969 revision of the Megathymidae is cited, Kilian Roever, who prepared this section, has sensibly chosen a rather different arrangement. Many of the *Agathymus* have been demoted to subspecies of several principal species such as *neumoegeni* and *mariae*. The western *Megathymus* have been reassigned to *yuccae* with *coloradensis* as a subspecies.

C. D. MacNeill who authored the Hesperidae section has revised his earlier work in lumping all of the *harpalus/manitoba* taxa under *comma*. Some of the other subspecies in *Hesperia* have been dropped without comment. The treatment of *Erynnis* generally follows Burns' 1964 revision. Overall, the coverage is good and the various species, especially the Mexican migrants, are figured, but many of the plates leave much to be desired regarding color fidelity. Occurrence in the U.S.A. of some of the doubtful Mexican species would have been confirmed had several museum and private collections been examined more carefully. Several species cited as occurring in Wyoming should be considered doubtful and may relate to misidentifications as I have no confirmed records. The lack of genitalic sketches is a major omission.

In summary, the book has some good points and some good sections, but on the whole, in this reviewer's opinion, it exhibits some serious faults. Many of the problem areas could have been resolved had the manuscript been submitted to

several competent technical reviewers prior to publication. The selection of the majority of the contributors from the West Coast has lent an unfortunate parochial flavor to the text. One receives the distinct impression that there is nothing of taxonomic interest east of the Great Basin. The plates are a major disappointment, especially in the lycaenids and hesperiids where they are most needed. It is unfortunate that this book, which had the potential for being a really definitive treatise on the North American butterflies, has fallen so far short of the mark. I am sure that there will be those who will praise the book, citing its utility to amateurs and the fact that nearly every North American species is figured. To them, I would reply that while the book has its good points, the novice collector can be easily misled in a number of areas because of problems with the text and illustrations. As a consequence of the number of flaws which produce frustration in the reader, the work as a whole must be considered as marginally worth the price.

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MITES OF MOTHS AND BUTTERFLIES, by Asher E. Treat. 1975. Cornell University Press, Ithaca, N. Y., 362 p., 150 figures (Frontispiece in color). Price \$35.00 (U.S.).

Clearly a classic work both for substance, including a remarkable amount of original (unpublished) material, and for scholarly and poetic style! The introductory section covers a concise history of mite-moth scientific discovery, a fine chapter on methods of study and a brief, thoughtful account of the important characteristics of mites.

In the body of the book, major sections (Mesostigmata: Acariformes) and chapters are presented under higher taxa headings, for the mites, but within each chapter the arrangement is "... primarily ecological at familial or lower levels" (Author's preface).

This is also a well-edited and very useful book with (1) 150 figures of excellent quality, (2) lists of moth-mite and mite-moth records, (3) keys to mites recorded from moths, (4) an extensive bibliography and (5) geographic and general indexes. The book should be read by not only "lepidopterists, acarologists and parasitologists" (vide Author) but by all amateur and professional scientists.

Mites of Moths and Butterflies will form a solid foundation for and be a lasting stimulus to future studies in many fields of scientific research. Truly a basic excellent book for any lepidopterist's library.

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BUTTERFLIES OF LEBANON, by Torben B. Larsen. 1974. National Council for Scientific Research, (C.N.R.S.), Beirut, Republic of Lebanon, xv + 255 p. Price: £7.50 sterling (U.K.), \$22.50 (U.S.). Distributed in the U.K. by E. W. Classey, Ltd., Park Road, Faringdon, Berks. SN7 7DR, England, and in the U.S. by Entomological Reprint Specialists, P. O. Box 77224, Dockweiler Station, Los Angeles, California 90007, U.S.A.

A review is a very personal thing to the reviewer. Without attempting to pass moral judgment, recent events in Lebanon have made the writing of this review especially difficult. Make no mistake about it, though, Larsen has written a very good book, and the Lebanese National Council for Scientific Research is to be congratulated for producing it in its present form.

Larsen expends the first 76 pages in prefatory material: Lebanon's history from the naturalist's viewpoint, the zoogeography of the area, distributional patterns within the country, a comparison of the butterflies of Lebanon with those of surrounding countries, the economic importance of *Rhopalocera* and their classification, along with a Lebanese checklist. Detailed discussions of the 139 recorded species are given in the next 140 pages, and this discussion is followed by a few pages of possible, doubtfully and erroneously recorded butterflies.

The sixteen color plates, identified by the text pages they face, range in quality from excellent to at least acceptable. Probably the least readable plate is that facing page 193, which is too dark and too red; some others are a bit too dark, but all are quite usable. It is unfortunate that the plates do not have figure numbers, but one soon becomes accustomed to the legends, and the exact details of the capture of each figured specimen are given, a policy that should achieve greater currency.

The text, however, is where the book really excels. There is a wealth of information tucked into these pages, information that is so well documented that one is left with the impression that he could return to those spots at the appropriate times and be virtually assured of collecting the insects. Available foodplant information is given and original sources on life histories are cited, where available; when the early stages are unknown, informed speculation on possible foodplants is offered. Habitat information is detailed and based on the author's personal experience in most cases; in others the best available information is cited.

A single taxon is described as new in the book, but three others were to have been proposed before the present publication. These were to have been described in *Alexanor* during 1974, but publication was delayed, and the inclusion of these names in *Butterflies of Lebanon* does not constitute valid descriptions. These names, in the context of the book, are *nomina nuda*, as Larsen correctly states. By the time this review is printed these names will be validated, but they cannot be dated from 1974, as stated in the text.

This book is a fine investment for anyone interested in Middle Eastern butterflies or for one who wants a wealth of recent biological information about them.

LEE D. MILLER, *Allyn Museum of Entomology, 3701 Bayshore Road, Sarasota, Florida 33580.*

GENERAL NOTES

LIBYTHEANA BACHMANNII (NYMPHALIDAE) IN CONNECTICUT

Libytheana bachmannii (Kirtland) is considered a rare vagrant in Connecticut to the local lepidopterists and reaches the northern terminus of its range in this area (Klots, 1951, A Field Guide to the Butterflies, Houghton Mifflin Co., Boston). Those that do occur are suspected to be immigrants from more southern territories and stay till they are lost to winter kill. There being only three Connecticut specimens in collections, it was unusually interesting to make several observations of this species during 1974.

All specimens have taken in Guilford, Connecticut, and it is from this town that all present observations were made. Between 18 and 20 June three individuals were seen. One fed on Mock Orange (*Philadelphus coronarius* L.) and two rested on bark of Apple (*Malus* sp.). In each case there were considerable nearby stands of Hackberry (*Celtis occidentalis* L.), the larval hostplant of *L. bachmannii*, leading to suspicions of a possible summer brood by the immigrants.

On 3 October three additional Snout Butterflies were encountered in an area with a half mile radius. Again *Celtis occidentalis* was quite common. However, in each case the butterflies were seen resting and possibly feeding on the fruits of Wineberry (*Rubus phoenicolasius* Maxim.). This fruit is very viscid to the touch, and its sweet juice would be a logical attractant.

Only future observations will show whether there is indeed a summer brood of *L. bachmannii* in the Guilford area.

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A CLAMP FOR MARKING BUTTERFLIES IN
CAPTURE-RECAPTURE STUDIES

I have recently begun a study of adaptive differences in social behavior of several species of butterflies near Whitehall, Washington Co., New York. I initially used techniques described by Ehrlich & Davidson (1960, J. Lepid. Soc. 14: 227-229), in which two people first capture all the butterflies in a given area, then mark and release them en masse in a central location. Although this program was adequate for some species, the observed pattern of local dispersal of sedentary species was greatly affected for a period of several days by the spatial pattern of my collecting and releasing. The affected species showed the least variation in individual behavior when individuals were marked and released quickly at the site of capture. So I designed and built a clamp that allows speedy and efficient marking at the site of capture by a single person (see Fig. 1).

The base is made of $\frac{1}{8}$ " Masonite, as is the anvil, which is glued to the base with its smooth side up. The softwood fulcrum is glued to the base. The "hinge" pins are # 18 brads that are driven through the base, cut short and filed smooth. The clip is made of $\frac{1}{16}$ " clear acrylic plastic with $\frac{1}{16}$ " holes to clear the pins and seven $\frac{5}{16}$ " holes in an H pattern as shown, each chamfered from the top with a countersink. The pieces may be cut roughly, and the assembled clamp shaped on a vertical power-sander. A rubber band holds the jaws of the clamp together. A hole in the upper end of the base allows the clamp to be carried accessibly on a hook or string about the waist or neck.

A butterfly is placed between the jaws of the clamp, and a small number is written on its forewing, using a permanent fiber-tipped pen (e.g., Sanford "Sharpie" at the suggestion of L. E. Gilbert). The several chamfered holes accommodate

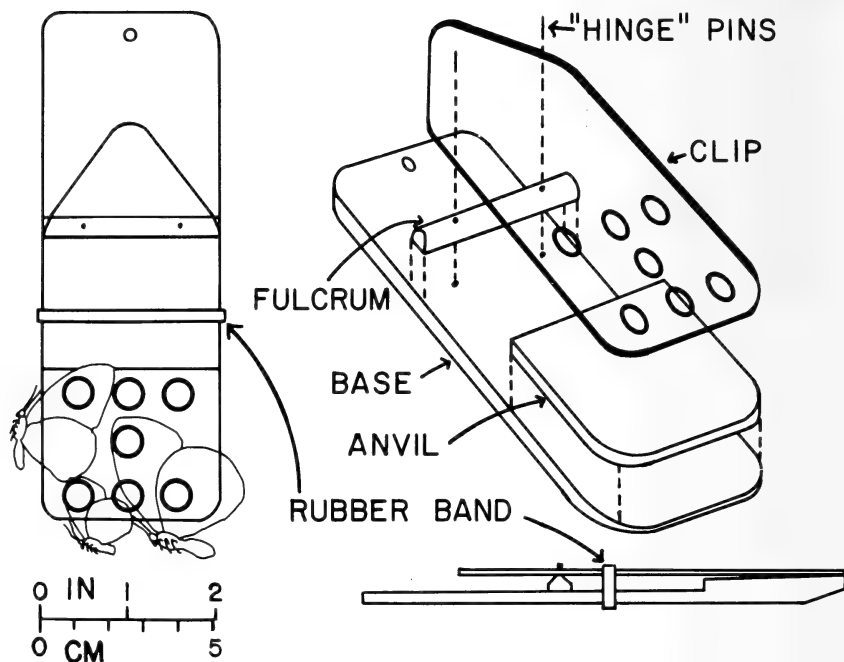


Fig. 1. Top, side and "exploded" views of the clamp.

butterflies of various sizes, and the pressure of the clip is adjustable by moving the rubber band back and forth between the fulcrum and the anvil. Since the clip is transparent, accurate measurements can be made of the wing length, presence and size of spots, etc. The butterfly is turned over and marked on the other side after the number on the first side is thoroughly dry.

During a total of 21 weeks in the summers of 1974 and 1975, I used this clip to mark 1,612 individuals of 28 species, varying in size from tailed blue (*Everes comyntas* Godart) to tiger swallowtail (*Papilio glaucus* Linnaeus). Marked individuals were recovered a total of 950 times. I had little success with blues (Plebejinae), which are simply too tiny and delicate and I had difficulty with freshly eclosed pearl crescents (*Phyciodes tharos* Drury) and bronze coppers (*Lycaena hyllus* Cramer), which combine delicate wings with hefty wing muscles. Painted ladies (*Vanessa cardui* Linnaeus; *V. virginiensis* Drury) and skippers (Hesperiidae) cannot be held firmly because their straight wings, wide bodies and strong muscles give them a mechanical advantage over the clip unless they are clamped close enough to the body to risk damage to their wings. Other species rarely caused trouble. Large species could escape if they could reach something to pull against with their feet. Very rarely, an individual would damage its wing mechanism trying to escape; such individuals appeared superficially unharmed, but were unable to fly and seldom recovered.

The clip can also be used to capture feeding or strutting hairstreaks (Theclinae) directly, with greater success and less damage than netting.

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PAPILIO TROILUS (PAPILIONIDAE) IN PURSUIT OF FISH CROW

On 13 August 1974 while crossing a dike of an impoundment in the Barn Island Wildlife Management Area, Stonington, Connecticut, I noticed two fish crows (*Corvus ossifragus* Wilson) flying about 200' over the marsh. This species is uncommon in that area and was therefore of interest. As I watched, a spicebush swallowtail (*Papilio troilus* L.) climbed toward the second bird, actually circled it and darted in on the bird. Such a response, elicited by the stimulus of a flying object such as a bird passing nearby has been reported by others, monarch (*Danaus plexippus* (L.)) and red-winged blackbird (*Agelaius phoeniceus* L.) by Slansky (1971, J. Lepid. Soc. 25: 294), Lorquin's admiral (*Limenitis lorquini* (Boisduval)) and glaucous-winged gull (*Larus glaucescens* Naumann) by Pyle (1972, J. Lepid. Soc. 26: 261) and question mark (*Polygonia interrogationis* (Fabricius)) with chimney swifts (*Chaetura pelagica* L.) by Hendricks (1974, J. Lepid. Soc. 28: 236).

I was quite surprised, however, to see the crow twist in the air, grasp the butterfly in its bill and eat it! I know of no other records for this species of bird eating this type of food and certainly corvids do not normally capture prey while in flight. Therefore, not only were the swallowtail's actions of interest but also the behavior and diet of the fish crow!

Pre-courtship responses and aggressive territorial behavior have been listed as possible explanations for the butterfly's actions. One can only conjecture what the butterfly was intending.

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MORE RECORDS OF BUTTERFLIES AS PREY FOR AMBUSH BUGS
(HETEROPTERA)

In a recent publication (Pyle 1973, J. Lepid. Soc. 27: 305-307) it was related that a butterfly, *Boloria selene*, (Denis & Schifferrmüller), was discovered being fed on by two unidentified ambush bugs (Phymatidae) on a flower head in Washington State. It was indicated that ambush bugs were not known to capture butterflies. This writer has made numerous observations of attacks on butterflies by crab spiders and certain insects, including ambush bugs. Recorded here are observations in Maryland of ambush bugs capturing certain butterflies.

A single observation of this behavior was made in 1969. However, during extensive collecting throughout Maryland in 1973-1975, 13 additional butterflies of 10 species were seen being fed upon by ambush bugs, which evidently had captured the butterflies. In each case the prey and predator were collected and preserved. In one instance two ambush bugs were captured feeding on a single butterfly. Of the 15 ambush bugs collected, only 4 were nymphs. Each butterfly was on a flower head and probably was attacked while feeding. Except for two specimens, the butterflies were fresh or nearly fresh. The ambush bugs were identified as *Phymata fasciata* (Gray). The adults averaged 8.9 mm and the nymphs 5.5 mm in length. Data on the butterflies captured by the ambush bugs are tabulated in Table 1.

From these data it can be surmised that captures of butterflies by ambush bugs may be quite common. Although this behavior is referred to in older texts, it has been generally overlooked by collectors. Comstock, Comstock & Herrick (1895. *A Manual for the Study of Insects*. 19th ed., Comstock Publ. Co., Ithaca, N.Y.), in discussing ambush bugs, stated, "It overpowers and captures insects like cabbage butterflies, honey-bees and large wasps." Lutz (1918, *Field Book of Insects*. 2nd ed., G.P. Putnam's Sons, New York), in a similar discussion, stated, "it conceals

Table 1. Butterflies captured by *Phymata fasciata* (Gray) in Maryland.

Species and Sex	Date	Town (County)	Flower Host
HESPERIIDAE			
<i>Poanes viator zizaniae</i> Shapiro ♂	29 July 73	Benedict (Charles)	<i>Apocynum</i> sp.
<i>Atalopedes campestris</i> (Boisduval) ♂	15 Sept. 74	Plum Point (Calvert)	<i>Apocynum</i> sp.
<i>Atalopedes campestris</i> (Boisduval) ♂	14 Sept. 75	Plum Point (Calvert)	<i>Tagetes</i> sp.
<i>Pompeius verna verna</i> (Edwards) ♀	9 July 74	Beltsville (Prince Georges)	<i>Asclepias</i> sp.
<i>Pompeius verna verna</i> (Edwards) ♀	21 Aug. 74	Ridge (Saint Marys)	<i>Solidago</i> sp.
<i>Polites coras</i> (Cramer) ♀	15 Aug. 73	Hall (Prince Georges)	<i>Asclepias</i> sp.
<i>Epargyreus clarus clarus</i> (Cramer) ♂	22 June 75	Benedict (Charles)	<i>Apocynum</i> sp.
PIERIDAE			
<i>Colias eurytheme eurytheme</i> Boisduval ♀	29 Sept. 73	Plum Point (Calvert)	<i>Chrysanthemum leucanthemum</i> L.
LYCAENIDAE			
<i>Strymon melinus humuli</i> (Harris) ♂	14 Aug. 69	Beltsville (Prince Georges)	<i>Trifolium repens</i> L.
<i>Lycaena phlaeas americana</i> Harris ♂	9 Aug. 75	Beltsville (Prince Georges)	<i>Solidago</i> sp.
NYMPHALIDAE			
<i>Cynthia virginienensis</i> (Drury) ♂ (two predators)	10 July 73	Plum Point (Calvert)	<i>Asclepias</i> sp.
<i>Phyciodes tharos tharos</i> (Drury) ♂	4 Aug. 73	Indian Head (Charles)	unidentified
<i>Phyciodes tharos tharos</i> (Drury) ♀	19 Sept. 73	Huntingtown (Calvert)	<i>Solidago</i> sp.
<i>Boloria toddi ammiralis</i> Hemming ♂	31 Aug. 73	Hancock (Washington)	<i>Apocynum</i> sp.

itself in flowers, where it captures various insects including large butterflies and even bees." However, the more recent text of Borror & DeLong (1954, *An Introduction to the Study of Insects*. 3rd ed., Holt, Rinehart, & Winston, New York) did not list butterflies as prey of Phymatidae.

ACKNOWLEDGMENT

The author thanks Dr. Jon L. Herring, Systematic Entomology Laboratory, U.S.D.A., for identifying the ambush bugs.

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PAPILIO XUTHUS (PAPILIONIDAE) IN HAWAII

The Hawaiian Islands have a very limited butterfly fauna—the only large butterfly is the monarch (*Danaus plexippus* (L.)), and medium-size species are limited to several species of *Cynthia* and *Pieris rapae* L. (Zimmerman, 1958, *Insects of Hawaii*. Vol. 7: *Macrolepidoptera*, Univ. of Hawaii, Honolulu). I was very surprised, therefore, on 6 February 1975 to observe a cream and white swallowtail fluttering around hibiscus bushes planted in the lawn of a condominium two miles north of Kaanapali on the island of Maui.

Although an attempt at hand capture failed, in the process of achieving a "near miss" I was able to tentatively identify the butterfly as *Papilio xuthus* L., a native of Japan and East Asia. Numerous other individuals were observed in the next few days, and the identification was confirmed when I obtained a net and captured a short series of specimens. Since *P. xuthus* is a member of the Rutaceae-feeding group of Papilios, an immediate search was made of local *Citrus*. Eggs, young larvae and pupal skins were found, and two individuals were reared on young citrus leaves (the larvae showed no interest in the tough older leaves).

Because of the potential importance of *P. xuthus* as a citrus pest, I notified the Hawaiian Department of Agriculture in Honolulu by telephone and was informed that they were aware of the introduction. In a subsequent letter, Ronald Mau, Survey Entomologist for the Department, kindly sent me the following information. *Papilio xuthus* was first discovered on Oahu in April 1971 and has now reached all the major Hawaiian Islands. It was first observed on Maui in May 1974 (I would guess that there was only a single introduction there since 10 months later the generations still appeared to be synchronized).

A chalcoid wasp egg parasite, *Trichogramma* spp., according to Mau appeared to be giving good control, and a tachinid fly, *Exorista sorbillans* (Wiedmann), parasitic on the larvae has been introduced to supplement *Trichogramma*. Its successful establishment is not certain at present. Mau also reports that *P. xuthus* pupae underwent some type of obligate diapause in 1971 and 1972, although adult and larval activity did not cease entirely.

More observations on the behavior of this newly introduced species would be most interesting. In March 1975 on Maui, *P. xuthus* adults were abundant and large numbers of eggs and larvae were present on cultivated citrus, showing every sign that the population was in the "log phase" of growth. There are native Rutaceae in the Hawaiian flora of the genera *Ptelea*, *Platydesma* and *Zanthoxylum*, and the impact of *P. xuthus* on these should be carefully observed.

It is interesting to speculate on the source of the introduction. One possibility that has been suggested is the accidental importation of a gravid female or two, but it is difficult to visualize such an "accident" with a large and attractive insect like *P. xuthus*. There is a more intriguing possibility. *Papilio xuthus* is known from the Bonin and Marianna Islands (Shirôzu, 1960, *Butterflies of Formosa in Colour*.

Hoikusha, Osaka). The only native Hawaiian lycaenid, *Vaga blackburni* (Tuely), has its nearest relative *V. ogasawaraensis* (Pryer) on the Bonin Islands. Zimmerman (op. cit., p. 494) suggests the possibility that "*blackburni* is a derivative of *ogasawaraensis*, or that they are descended from a common stock, and the original ancestors which populated Hawaii may have come from the Bonin Islands." So it is just possible that this beautiful addition to the Hawaiian fauna arrived by natural dispersal, carried more than 3000 miles by the westerly winds of the North Pacific.

PAUL R. EHRLICH, *Professor of Biology, Stanford University, Stanford, California 94305.*

CHARAXINAE (NYMPHALIDAE): OLD WORLD VERSUS NEW

The life history of *Anaea euryppyle confusa* Hall (Muyschondt 1974, J. Lepid. Soc. 28: 306-314) reveals some interesting differences between this species and the Old World Charaxinae. First, concerning the adults, is it quite certain that both sexes are attracted to dung and carrion? In the Old World species, only the male is so attracted, although both sexes are attracted to fermenting fruit and sap. It has been suggested that the male's attraction to dung and carrion may have some connection with the male metabolism with regard to courtship and mating. This is comparable, perhaps, to the requirements of certain male danais for the juices of withered plants of the Boraginaceae as a precursor of the male pheromones used in courtship.

With regard to the larvae, I know of no Old World species in which the young larva constructs a perch of frass and silk on which it rests between feeds, and, as can be seen from Dr. van Someren's list of foodplants (1974, J. Lepid. Soc. 28: 315-331), the East African Charaxinae have been bred extensively. The Old World larvae usually spin a carpet of silk, without frass, on which they rest between feeding. I also know of no Old World species that makes a retreat by rolling or folding a leaf. Strangely enough, the young larvae of the genus *Asterope* (Eumicinae) and *Cyrestis camillus* F. (Marpesiinae) do have this habit of constructing a perch of silk and frass on which to rest, but none of these rolls or folds a leaf when larger.

Generally, the pupae of the Old World Charaxinae are green and monomorphic, but those of *Charaxes protoclea* Feisth. and *C. lasti* Gr. Sm. are dimorphic, having a green and a brown form. It seems highly probable that the pupae of the closely allied *C. boueti* Feisth. and *C. cynthia* Btlr. are dimorphic also.

D. G. SEVASTOPULO, *P.O. Box 95026, Mombasa, Kenya.*

NOTES AND NEWS

Recent Letters

Dear Sir,

A paper by Benton and Jennings (1975, Lepid. Soc. 29: 192-194) gives a photographic figure of a pupal anomaly. It also mentions in the text examples of hysterotely by Cockayne (1927) and Haggett (1954) with the comment "None of these cases is similar to the *R. neomexicana* pupal anomaly."

The LITERATURE CITED, at the end of the paper, omits several quite important references, among them:

Hawkins, C. N. 1933. Trans. Roy. Ent. Soc. Lond. 81: 223.

———. 1938. Proc. Roy. Ent. Soc. Lond. 13: 92.

Evans, E. 1940. Entomologist 73: 134.

Cockayne, E. A. 1942. *Ibid.* 75: 49.

Classey, E. W. 1942. *Ibid.* 75: 151.

In the last mentioned paper, figures are given of the anomalies of segmentation in the larva, pupa and adult of the same specimen.

From the figure of the pupa, it will be seen that the segmentation is very closely similar to that of *Rhyacionia neomexicana* shown in Benton and Jennings' paper. The main differences are that an extra segment is involved and the spiral in the case of Classey (1942) for *Malacosoma neustria* Lin. is sinister and in the other, dexter.

E. W. Classey

Dear Dr. Godfrey,

The pupa described and figured in Benton & Jennings' paper (1975, J. Lepid. Soc. 29: 192-194) appears, from the photograph, to be a fairly typical example of spiral segmentation, the spiral affecting the 2nd, 3rd and 4th abdominal somites. The authors, whilst referring to Cockayne's paper on prothetely and hysterotely, quite different phenomena, rather strangely make no mention of Cockayne's papers dealing specifically with spiral segmentation (1929, Trans. Ent. Soc. Lond. 77: 177-184 and 1934, *Ibid.* 82: 165-172). In these papers Cockayne describes and figures spirals in a number of insects belonging to various Orders, and discusses the probable origin and cause of the phenomenon. He is definitely of the opinion that it arises during the development of the ovum. There is a later paper by Cockayne (1942, Entomologist 75: 49-54) in which he records further cases that had come to light since his 1934 paper, and in which he records his opinion that the condition has a genetic basis, the gene probably being recessive and with very poor penetration.

Since these papers were published, I can trace very few accounts of spiral segmentation in the English language journals available to me. Classey (1942, Entomologist 75: 151-152) describes and figures an example in the lasiocampid *Malacosoma neustria* L., and there are three papers dealing with examples that I have bred, viz. a brood of *Leucania irregularis* Wlk. (Noctuidae) (1948, Entomologist 81: 38-40), a brood of *Euxanthe wakefieldi* Ward (Nymphalidae) (1965, Entomologist 98: 107) and a single *Acherontia atropos* L. (Sphingidae) (1966, Entomologist 98: 107).

D. G. Sevastopulo

OBITUARY

MAURICE LOUIS BRISTOL (1890-1975)

Maurice Louis Bristol, a charter member of The Lepidopterists' Society, died at his home in Elgin, Illinois on 13 February 1975. He was born in Naperville, Illinois, 23 March 1890, and moved to Elgin in 1906. He was employed by the Elgin National Watch Company and later by the David C. Cook Publishing Company until his retirement. He never married and is survived by two brothers, Harris and George, and two sisters, Mrs. Hattie Graves and Mrs. Lucy Miller.

Bristol began to collect butterflies as a boy of eight. He was an all-around naturalist of the old school, whose interests in addition to Lepidoptera included Coleoptera, birds, fossils, nature photography and plants, especially native prairie species, which he grew in his back yard. When the Audubon Society of Kane County, of which he was also a charter member, reconstructed a small patch of native prairie north of Elgin, he donated many of the plants for it, and it was named in his honor. He actively encouraged young people in developing an interest in nature and was well known in Elgin for his activities and his devotion to children.

Bristol's collecting in the Elgin area yielded such Illinois rarities as *Glaucopteryx lygdamus couperi* Grote and *Chlosyne harrisii* (Scudder), as well as most of the known Illinois specimens of *Calephelis muticum* McAlpine. He rediscovered the classic Wakelee, Michigan type locality of *Euptychia mitchelli* (French) in the late 1920's and collected there regularly for many years. His particular interests were *Apantesis*, *Catocala*, *Schinia*, *Papaipema* and Theclinae. He maintained an extensive correspondence and exchange with other lepidopterists.

I remember encountering Maurice at Wakelee on my first visit there a number of years ago. Then nearly 70, he was collecting with an energy that I, less than half his age, envied. He retained that vigor and continued active field work until the end of his life; at the time of his unexpected passing he was busily planning for his next season. His collection has been acquired by the Illinois Natural History Survey. Unfortunately, some of it was found to have suffered dermestid damage, but the greater portion was intact and will be incorporated into the Survey's research collection.

The assistance of Bristol's friend and collecting companion Irwin Leeuw, and his sister, Mrs. Hattie Graves, in the preparation of this article and in arranging for the transfer of his collection to the Survey is gratefully acknowledged.

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Contributions to the *Journal* may deal with any aspect of the collection and study of Lepidoptera. Contributors should prepare manuscripts according to the following instructions.

Text: Manuscripts should be submitted in *duplicate*, and must be typewritten, *entirely double-spaced*, employing wide margins, on one side only of white, $8\frac{1}{2} \times 11$ inch paper. Titles should be explicit and descriptive of the article's content, including the family name of the subject, but must be kept as short as possible. The first mention of a plant or animal in the text should include the *full scientific name*, with *authors* of zoological names. Insect measurements should be given in *metric units*; times should be given in terms of the *24-hour clock* (e.g. 0930, not 9:30 AM). Underline only where *italics* are intended. References to footnotes should be numbered consecutively, and the footnotes typed on a separate sheet.

Literature Cited: References in the text of articles should be given as, Sheppard (1959) or (Sheppard, 1959, 1961a, 1961b) and all must be listed alphabetically under the heading LITERATURE CITED, in the following format:

SHEPPARD, P. M. 1959. Natural selection and heredity. 2nd. ed. Hutchinson, London. 209 p.

——— 1961a. Some contributions to population genetics resulting from the study of the Lepidoptera. *Adv. Genet.* 10: 165–216.

In the case of general notes, references should be given in the text as, Sheppard (1961, *Adv. Genet.* 10: 165–216) or (Sheppard 1961, *Sym. Roy. Entomol. Soc. London* 1: 23–30).

Illustrations: All photographs and drawings should be mounted on stiff, *white* backing, arranged in the desired format, allowing (with particular regard to lettering) for reduction to their final width (usually $4\frac{1}{2}$ inches). Illustrations larger than $8\frac{1}{2} \times 11$ inches are not acceptable and should be reduced photographically to that size or smaller. The author's name, figure numbers as cited in the text, and an indication of the article's title should be printed *on the back* of each mounted plate. Figures, both line drawings and halftones (photographs), should be numbered consecutively in Arabic numerals. The term "plate" should not be employed. *Figure legends* must be typewritten, double-spaced, *on a separate sheet* (not attached to the illustrations), headed EXPLANATION OF FIGURES, with a separate paragraph devoted to each page of illustrations.

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Address all correspondence relating to the *Journal* to the editor. Material not intended for permanent record, such as current events and notices, should be sent to the editor of the *News*: Ron Leuschner, 1900 John Street, Manhattan Beach, California 90266.

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THE OVERWINTERING SITE OF THE EASTERN POPULATION OF THE MONARCH BUTTERFLY (*DANAUS P. PLEXIPPUS*; DANAIDAE) IN SOUTHERN MEXICO

F. A. URQUHART AND N. R. URQUHART

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Twenty-five years have passed since we started an intensive investigation of the movements of the monarch butterfly (*Danaus p. plexippus* (L.)) in North America, although experiments concerned with methods of identifying specimens of a moving population were conducted from 1937–1939. The question to be answered was: “Where is the final destination of the migrating monarchs?”

Over the years we have had the assistance of thousands of volunteers living in various parts of North America. Over 300,000 monarchs were alar tagged (Urquhart, 1960, 1966). In addition, through numerous field expeditions on which we traveled more than 100,000 mi. during the 25-year period, we investigated the presence of monarchs (larvae and imagoes) and the host plants in most parts of southern Canada, the United States, Mexico, and Central America. Some data were obtained as a result of visits to 56 colleges and universities to examine insect and plant collections and discuss the project with our colleagues.

In January 1975, the overwintering colony of the monarch was finally located. We were able to join an expedition in January 1976 to view for ourselves this most spectacular sight—the final southern destination of the eastern population of the migrating monarch butterflies.

Description of Site

The overwintering colony described in the present paper was located on the slope of a volcanic mountain situated in the northern part of the State of Michoacan, Mexico, at a height of slightly over 3,000 m (Fig. 1). The predominant tree, averaging 26 m in height, was the



Fig. 1. A, area over which monarch butterflies of the eastern population are known to breed; B, area of greatest concentration around the Great Lakes; C, overwintering site of the eastern population; D, location of migrants in southeastern Mexico and Guatemala (Urquhart & Urquhart 1976); E, aberrant migration composed of a small portion of the eastern population that reaches the base of the Florida peninsula and continues southward; F, possible route taken by the aberrant Florida migrants. Note: the breeding area of the western population lies within the mountain valleys with overwintering on the California coast.

Oyamel (*Oyamel mexicano* (Dougl.)). The colony occupied an area of roughly 20 acres. The trunks and branches of the Oyamel trees were completely covered with monarchs (Fig. 2)—only small portions of the crowns of the trees were bare as a result of the action of the mountain winds dislodging the butterflies. The monarchs were so closely packed together on the trunks that it was impossible to see even a small portion of the underlying bark. The branches were not only completely covered,



Fig. 2. Clusters of monarch butterflies on three of over a thousand Oyamel trees in the overwintering site. The trunks of the trees are also completely covered. Because of higher temperatures and exposure to the sun through a forest clearing, the monarchs in this photograph have spread their wings. During the evening and throughout the night and early morning, the wings remain closed. Color photographs appear in an article in the *National Geographic Magazine* (August 1976).

from the smallest terminal twig to the base, but the butterflies clung to each other to a depth, in some instances, of 10 cm. One such branch, ca. 2 m in length with a base 4 cm in diam., was so heavily laden with butterflies that it broke, spilling countless thousands of monarchs upon the ground beneath the tree. The forest floor throughout the area was sprinkled with monarchs that, having been dislodged from the trees, were unable to fly because of the low temperatures at this altitude. In some locations the ground was covered to an average depth of 10 cm. It was impossible to walk over the area without crushing hundreds of monarchs underfoot, so, to avoid such wanton destruction, the field party limited its tagging activities to one small area near a forest clearing.

During the early part of our visit (January 7–21) the temperature on the mountain slope varied from a low of -1° C at night and in the early morning to a high of 13° C in the afternoon. During cloudy periods and periods of rain or snow, the daytime temperature remained at an average of 10° C. In the cool periods the monarchs remained inactive with wings closed. With the advent of higher temperatures, many of them, particularly in areas where the sun shone through the Oyamel branches, opened their wings, presenting a magnificent display of color. At such times thousands would take to wing, filling the air over the forest clearing. As the temperature dropped, the monarchs returned to the trees and remained inactive during the night and early morning. Occasionally there was a slight snowfall. Monarchs shaken from the Oyamel branches were found fluttering on the snow surface. With the advent of warmer temperatures, the light snow cover would melt and the monarchs would return—either by flight, in areas where the sun could reach them, or by crawling—to roosting sites—trunks and branches of the Oyamel trees, bushes, or upright dead branches of fallen trees.

To estimate the possible number of monarchs roosting upon one small Oyamel branch, the following procedure was conducted. A small branch, 1.5 m in length, weighed down by its burden of butterflies, was located 2 m from the ground surface. The distance from the ground to the tip of the branch was measured. The roosting monarchs were then removed, which allowed the branch, relieved of its burden, to return to its unweighted position. One end of a cord was tied to the branch, about $\frac{1}{3}$ from the tip, and the other end to a bag. A number of stones were placed in the bag, which caused the tip of the branch to return to its monarch-laden position. On returning to our base, we were able to weigh the bag and its content of stones, which came to 3,800 gm.

Knowing the weight of one butterfly to be 0.61 gm, based on the weight of 50 specimens of both sexes, the estimated number of monarch butterflies on this small branch is calculated to be 6,230. Since over a thousand trees, with branches much larger than the experimental one, together with the trunks and the forest floor, were covered with butterflies, some conception of the number of overwintering monarchs in the area can be imagined. An accurate estimate is, of course impossible, but the numbers would undoubtedly be in the millions.

On our last trip to the site, January 24, the afternoon temperature had risen to 22° C. Thousands of monarchs had left the trees and were flying about, filling the air with fluttering wings, a sight long to be remembered. A number of matings were taking place—pairs flew from one tree to another, and clusters of males and females copulated on the ground. As we climbed the slope of the mountain, we witnessed thousands upon thousands of monarchs heading on a compass bearing of true north. We had witnessed the first spring movement back to the breeding areas of the United States and Canada.

Two members of the field party returned to the site on February 9 to find that an estimated 75% of the butterflies had left the colony. Trees that were previously covered with monarchs were bare.

Predators

A few stray cattle were seen feeding extensively upon the monarchs that were on the ground and the lower portions of the tree trunks. The natives informed us that the cattle commonly fed upon monarchs and grew fat on the diet.

In addition to the predation by cattle, a number of species of birds fed upon the roosting monarchs. We procured one bird (later identified as *Myiarchus tyrannulus*, the Brown-crested Flycatcher) and found its crop and stomach filled with the bodies and a few wing scales of monarchs. The wings of the monarchs had been removed by the birds before ingesting the bodies. It seems reasonable to conclude that other birds did the same thing because the ground was covered with monarch wings that we saw falling from the trees and fluttering to the ground like so many dead leaves.

Tagging Program and Results

Three monarchs that bore our identifying alar tags were recovered at the overwintering sites. During the expedition of January 1975, one specimen tagged in Nevada, Missouri on 9 September 1974 and another tagged in Fredericksburg, Texas on 8 October 1974 were re-

captured. During the January 1976 expedition one specimen tagged at Chaska, Minnesota on 6 September 1975 was recaptured. Such recaptures indicate that the site here described is the overwintering area for the monarch butterflies of the eastern population of North America.

During our field trips to the site, a total of 25,000 specimens were alar tagged. In view of the fact that the specimens at the site were in excellent condition with very little indication of wing fractures, we are confident that tagged monarchs from the overwintering colony will eventually be recaptured at various localities throughout the United States and Canada, thus indicating a return migration for at least a part of the eastern population. Such recaptures will be reported in subsequent publications.

ACKNOWLEDGMENTS

The study presented in this paper is part of a long-term investigation of the migrations and ecology of the monarch butterfly sponsored through grants from the National Research Council of Canada and the National Geographic Society of the United States, and donations from members of the Insect Migration Association. Permission to use the photograph of the overwintering monarchs on the Oyamel trees was granted by the *National Geographic Magazine*. The final discovery of the site was made possible by the active cooperation of thousands of volunteer field assistants living in various parts of Canada, the United States, and Mexico.

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NOTES ON THE LIFE CYCLE AND NATURAL HISTORY OF
BUTTERFLIES OF EL SALVADOR. VIII. *ARCHAEOPREPONA*
ANTIMACHE GULINA, *SIDERONE MARTHESIA*, *ZARETIS*
CALLIDRYAS AND *CONSUL ELECTRA* (NYMPHALIDAE)

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This article completes a series dealing with what my sons and I have learned about the early stages, larval food plants, and adult behavior of the Charaxinae found in El Salvador. As far as we know, the remaining local species of this group for which we have been unable to find the early stages, even though we have collected adults, are *Anaea* (*Anaea*) *aidea* Guérin-Ménéville, *A. (Memphis) nobilis* Bates and *A. (M.) glycerium* Doubleday. Another species of *Archaeoprepona* occurs here, but we unfortunately have been unable to capture an adult to have it determined. All these species are very scarce locally; only one or two specimens of some are known in local collections (including ours).

Life Cycles

Archaeoprepona antimache gulina Frühstorfer

This species is like *A. demophon centralis* Frühstorfer (Muyshondt, 1976) except for the following points:

Larva (Figs. 2-6). Dark brown dorsally during 1st and 2nd instars; 3rd instar lighter brown with a whitish spiracular area on 7th and 9th abdominal segments; 5th instar larva whitish dorsally from 3rd-9th abdominal segments, rest of body brown. During all instars the mesal thoracic prominence is larger than in respective instars of *A. d. centralis*.

Prepupa (Fig. 7). Prepupa changes to yellow instead of green.

Pupa (Figs. 8, 9). Pupa slightly more slender laterally than pupa of *A. d. centralis*.

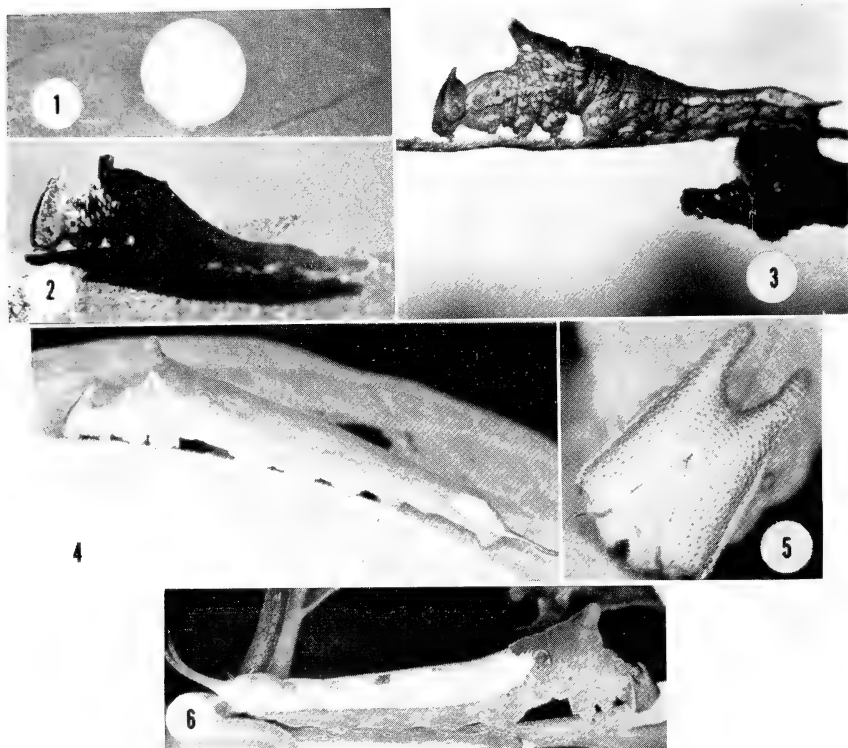
Adult (Figs. 10, 11). Same shape as *A. d. centralis* but colored triangle on dorsal surface of forewing and band on dorsum of hindwing are definitely iridescent light blue instead of iridescent greenish-blue. Ventral surfaces of wings mostly light gray instead of light brown with a complicated array of darker zones and black lines, more abundant than in *A. d. centralis*. The wingspan and developmental time are about the same as *A. d. centralis*.

Siderone marthesia Cramer

In all respects, this species is like *Zaretis itys* Cramer (Muyshondt, 1973b) but for the following:

Egg. Considerably larger, but same shape and color.

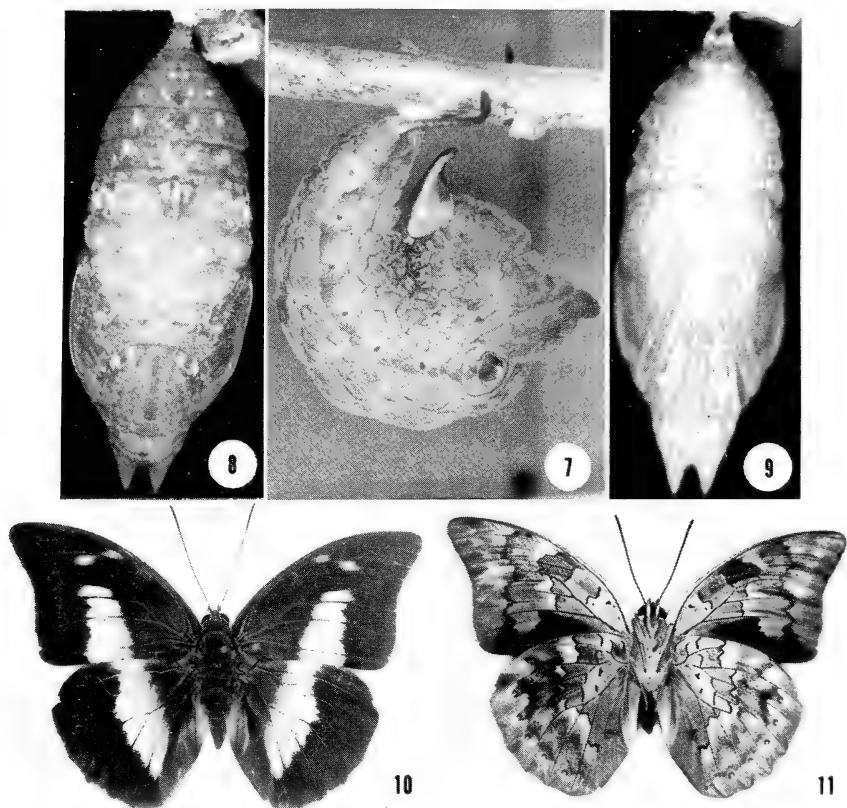
Larva (Figs. 12-16). Corresponding instars about 1½ times larger, lighter brown than *Z. itys*; caudal end rounded instead of bifid. Later instars with a white patch formed by short and thin spinulets subdorsally on mesothorax. Head horns very thick and knobby; head and its horns covered with short setae.



Figs. 1-6. *Archaeoprepona antimache gulina*. 1, Egg, width about 2.5 mm; 2, second instar larva, about 13 mm long; 3, third instar larva, about 30 mm long; 4, fourth instar, about 47 mm long; 5, head of fifth instar larva, note lateral projections; 6, fifth instar larva, about 80 mm long.

Pupa (Figs. 18-20). Bigger than but about the same shape as pupa of *Z. itys*. Green with dark markings along the spiracular zone and on the lateral edges of the wingcases. The latter have a marked indentation, lacking in *Z. itys*.

Adults (Figs. 21, 22). Sexually dimorphic. Wing of male: costal margin convex, apex pointed, outer margin S-shaped, tornus rounded and inner margin of forewing straight. Costal margin of hindwing strongly rounded basally, outer angle and margin rounded, anal angle slightly projecting, inner margin S-shaped. Female: larger with costal margin of forewing less convex than in the male, apex without a marked point, outer margin slightly convex, forewing not S-shaped. Hindwing as in the male. Dorsal color pattern of the male: forewing dark brown, almost black, with a slanting red bar from the mid-costal margin almost to the tornus and a red triangle basally, leaving a black band in between. Male hindwing mostly black or very dark brown with red markings of variable size starting from mid-costal margin, markings sometimes reduced to two or three spots or forming a band running toward the anal angle. Apex of front wing in some individuals red-tinged and with a very small white spot near costal margin of the subapical area. Females have same color pattern, but lighter brown with two subapical white spots on forewing and red markings of hindwing greatly reduced. Ventral wing surfaces of both sexes very



Figs. 7-11. *Archaeoprepona antimache gulina*. 7, Prepupa, note tails located on either side of twig; 8, pupa, dorsal view, about 42 mm long; 9, pupa, ventral view; 10, male, dorsal view, wingspan about 80 mm; 11, male, ventral view.

similar but darker in male: ground color dark brown with darker lines resembling leaf veins and lighter zones, the latter more evident on hindwing. Apex of forewing with some white sprinkling. The whole of ventral wing surfaces gives silvery sheen at certain angles. Thorax reddish above, yellowish below; abdomen brown. Antennae light brown; palpi and proboscis yellow. Wingspan of female about 7.0 cm, male 5.5 cm.

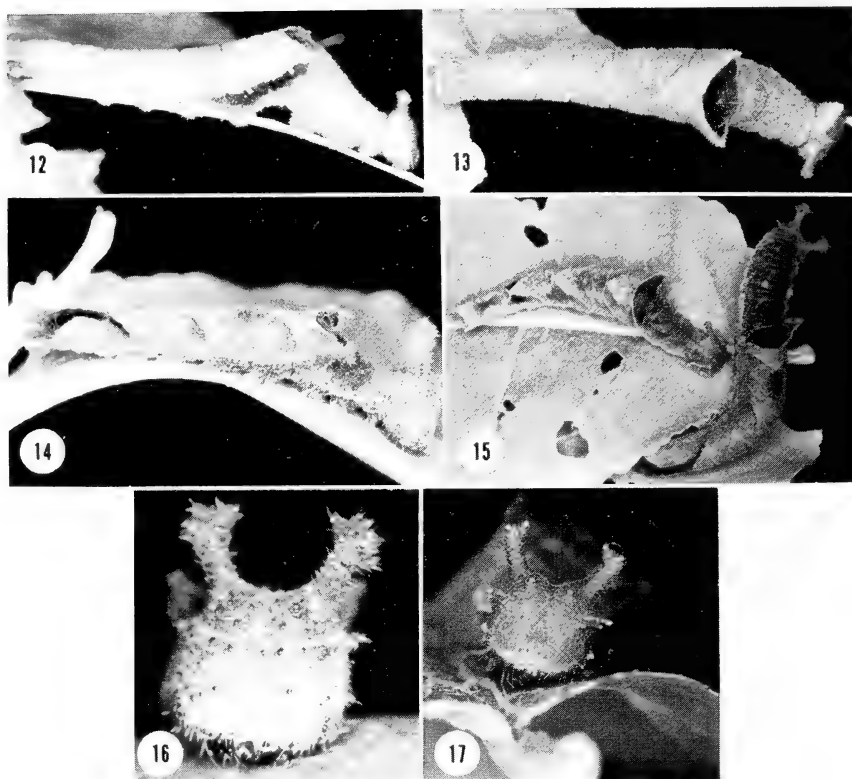
Zaretis callidryas R. Felder

A second instar of *Z. callidryas* was collected and at first thought to be a different morph of the common *Z. itys*. The larva was reared on *Cascardia silvestris* and *C. nitida*. During the later instars differences were noticed and photographed:

Larva (Fig. 23). Abdomen lighter dorsally than *Z. itys*; head smoother, without the typical *Z. itys* spines and the horns incurved posteriorly.

Pupa. Closely resembles the green morph of *Z. itys*.

Adult. The obtained adult was a tailed female. Its shape similar to *Z. itys* except for tail on M-3 of hindwing and less acute anal angle. Dorsal color predominantly



Figs. 12-14. *Siderone marthesia*. 12, Fourth instar larva, about 32 mm long; 13, same, dorsal view; 14, fifth instar larva, two days after molting, about 44 mm long.

Fig. 15. Left, *Zaretis itys*, fifth instar larva; right, *Siderone marthesia*, fifth instar larva, about 62 mm long. Compare caudal end of *Zaretis* with *Siderone*.

Figs. 16-17. Close-up of larval heads: 16, *Siderone* and 17, *Zaretis*.

white with pearly sheen; apex of forewing faintly gray. Outer margin of hindwing with submarginal row of small faint brown spots. Ventrally wings yellowish-white with faint markings as in *Z. itys*. Wingspan about 5 cm.

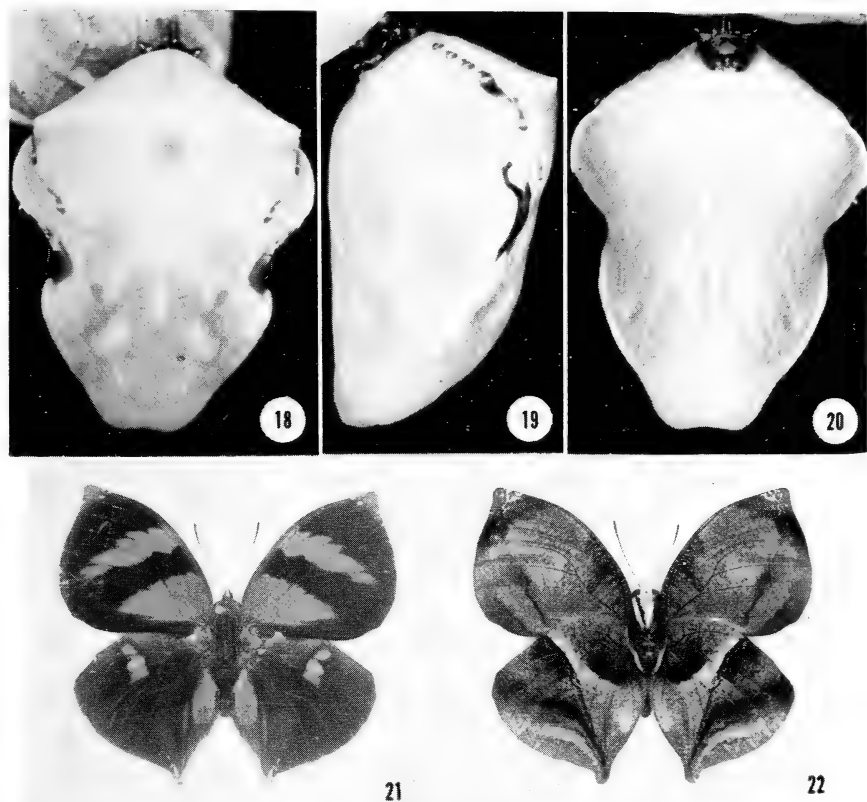
Consul electra Westwood

In its early stages, behavior and selection of food plant, this species is similar to *C. fabius* (Cramer) (Muyshondt, 1974) except for the following noticeable differences:

Larva (Figs. 26, 27). During 5th instar, head predominantly green with black near the horns and yellow frontal bands. In *C. fabius* the head is mostly black with yellow frontal bands.

Pupa (Figs. 28-30). Green and brown pupal morphs occur. Slightly wider laterally than in *C. fabius*; shows two dark spots dorsally on thorax.

Adult (Figs. 31-38). Adults not showing marked sexual dimorphism, but are amazingly polymorphic. Apex of forewing more or less elongate and acuminate; M-3

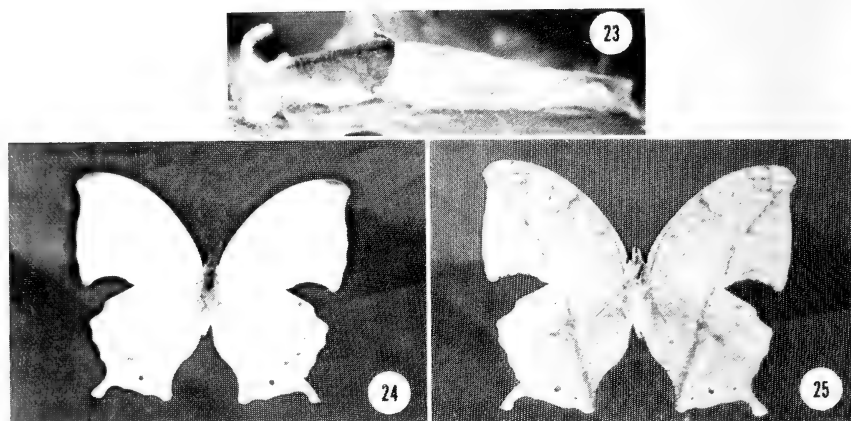


Figs. 18-22. *Siderone marthesia*. 18, Pupa, dorsal view, about 25 mm long; 19, pupa, lateral view; 20, pupa, ventral view; 21, male, dorsal view, wingspan about 55 mm; 22, male, ventral view.

of hindwing more or less elongate and spatulate, anal angle sometimes forming second tail. Dorsal and ventral colors more or less dark with some variations in color pattern. Variations in shape and color exist between individuals reared simultaneously, thus, not attributable to seasonal variation. Wingspan of female about 7.0 cm, male 5.5 cm.

Natural History

Archaeoprepona a. gulina behaves during its early stages and as an adult very much like *Prepona omphale octavia* (Muyshondt, 1973a) and *A. demophon centralis* (Muyshondt, 1976). It looks very much like the latter except for variations in color. The larva of *A. a. gulina* also reacts in a menacing manner by lifting the forked tail which is opened and closed scissor-like when prodded. During the later instars

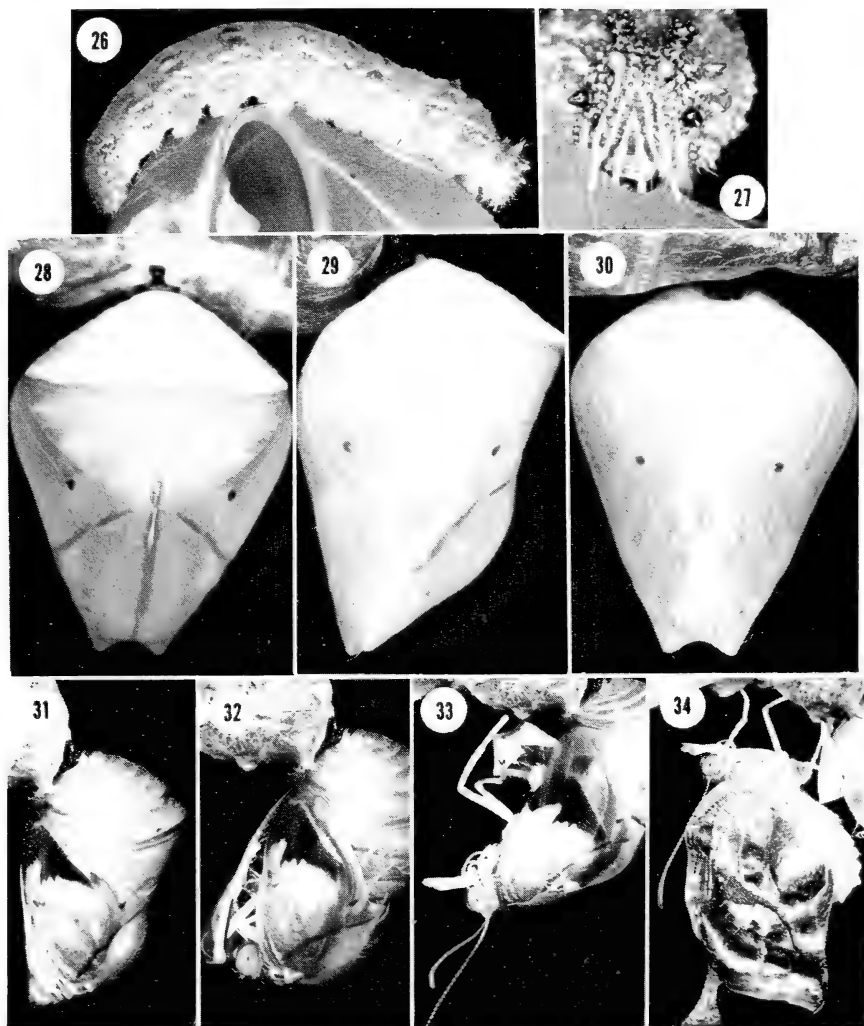


Figs. 23-25. *Zaretis callidryas*. 23, Fifth instar larva, about 40 mm long, note incurved horns, compare with *Z. itys*, Fig. 15; 24, female (tailed morph), dorsal view, wingspan about 50 mm; 25, female, ventral view.

it also has a reptilian aspect when viewed dorsally. This is due to a prominent dorsal projection which covers the head. The lateral aspects of the dorsal projection bear false eyes which enhance the effect. This prominence also is retractable.

A. a. gulina larvae feed on a Laurinaceae tree determined by Lic. Flores, Universidad Nacional, as *Nectandra sinuata*, which is the same food plant used by the larvae of *Anaea morvus boisduvali* Comstock (Muyshondt, 1975). Actually it was while searching for *A. m. boisduvali* eggs that the first eggs of *A. a. gulina* were found. The eggs of the latter species are also heavily parasitized by chalcidid wasps, and the small larvae are preyed upon by spiders. *A. a. gulina* occupies the same habitat as *A. demophon centralis*.

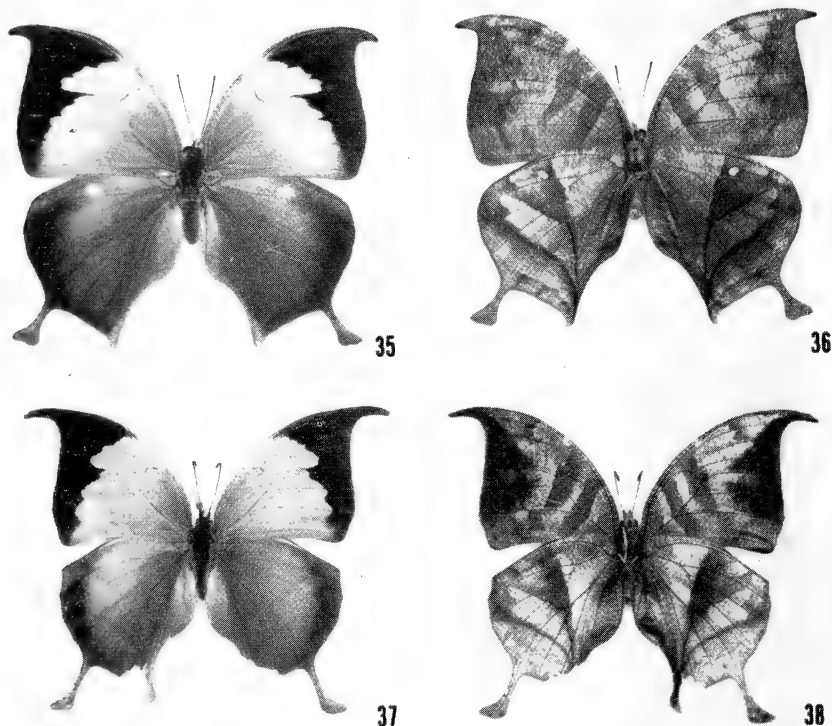
Siderone marthesia and *Zaretis callidryas* behave like *Z. itys* (Muyshondt, 1973b) and share its food plants: *Casearia sylvestris* and *C. nitida* although *Zaretis itys* appears to prefer the latter and *Siderone marthesia* and *Zaretis callidryas* the former. Both *S. marthesia* and *Z. callidryas* have been collected at an altitude of 1,000 m. *Z. itys* has a wider range. The females of *S. marthesia* are very seldom seen. Most of our observations have been of adult males; they have definite hill-topping behavior between 1030-1600 hr. They usually perch on the top branches of trees, and it is quite a feat to net them. Luckily they are attracted by fermenting banana baits, but we have never found females at the baits. However, Descimon *et al.* (1973) report several captures of females at baits near Colima, Mexico. We are unable to



Figs. 26–34. *Consul electra*. 26, Fifth instar larva, about 37 mm long; 27, close-up of larval head; 28, pupa, dorsal view, about 20 mm long; 29, pupa, lateral view; 30, pupa, ventral view. Emergence of adult: 31–34, sequenced from left to right.

comment on the behavior of adult *Zaretis callidryas* because the only specimen we have seen is the one reared in our insectary.

The behavior of the early stages and adult of *Consul electra* resemble those of *Anaea* (*Consul*) *fabius* Cramer (Muyshondt, 1974). The larvae of both use a number of species of Piperaceae as food plants. *C. electra* has been collected at higher altitudes than *fabius* (500–2,600 m). Both



Figs. 35–38. *Consul electra*. 35, Female, dorsal view, wingspan about 70 mm; 36, female, ventral view; 37, male (acute apex morph), dorsal view, wingspan about 55 mm; 38, male, ventral view.

species can be found simultaneously feeding on the same plants where their ranges merge at an altitude of 500–1,200 m. The adults do not visit flowers, but feed on fermenting fruits and excrement on the ground and on sap from tree cavities. The males are pugnacious and perch on shrubs at a height of 2–4 m. With *C. fabius*, *C. electra* is one of the slowest flyers among the local Charaxinae. The larvae and pupae are often parasitized by tachinid flies and chalcidid wasps.

DISCUSSION

Müller (1886) described the life cycles of various *Archaeoprepona* (under the generic name of *Prepona*), including *A. amphimachus* Fabricius on Laurinaceae (probably *Nectandra* spp.), *A. catachlora* Staudinger on *Mollinedia brasiliensis* Jul. (Monimaceae) and *A. demophon extincta* Staudinger on *Dugetia lanceolata* St. Hilaire (Anonaceae).

His descriptions conform closely with our own observations of *A. demophon centralis* (Muysshondt, 1976) and *A. antimache gulina* except for the eggs which he describes as having "very fine and crowded longitudinal ribs" which we have been unable to detect, even under 15 \times magnification. Müller also described the early stages of *Siderone ide* Hübner and *S. strigosus* Gmelin and claimed both species fed on *Casearia sylvestris*. However, *Siderone strigosus*, according to Comstock (1961), is a synonym of *Anaea (Zaretis) itys*. Furthermore, because Müller states that the early stages of "*Siderone strigosus*" are "as *ide*," it appears that his descriptions actually deal with two species of *Zaretis*.

After studying species of both genera (*Zaretis itys* (Muysshondt, 1973b), *Z. callidryas*, and *Siderone marthesia*), we are certain that there are notable differences between the early stages of the larvae of the two genera that would not escape the attention of an investigator. The only part in Müller's description of "*ide*" that would fit a *Siderone* pupa is "wing edge and stigma brown," yet he does not mention a drastic indentation (as seen dorsally and ventrally) at the brown mark on the wingcase of the pupa he described.

According to Comstock (1961), the only information about the early stages of *A. (Siderone) marthesia* is Müller's, however, we are certain that Müller's description was not of a species of *Siderone*. In Rydon (1971) there are some good painted illustrations of the larvae of *S. marthesia* and *S. nemesis* and their respective pupae copied from the original drawings of Miss M. E. Fontaine which were published by the Royal Entomological Society around 1910. However, Miss Fontaine apparently did not write any descriptions.

We are unaware of any previous publications on the early stages of *Zaretis callidryas*. The adult is figured in Seitz (1924) as an *Anaea* and is not likened to its close relative, *Zaretis itys*. Even in Lewis (1973) the tailless form of *Z. callidryas* is presented as an *Anaea*. The same is true with *Consul electra*. Seitz (1924) and Lewis (1973) present it as *Anaea electra* and do not relate it to its close relative, *Consul fabius*, which they picture as *Protogonius hippona* Fabricius.

We hope our descriptions and illustrations of the species we have studied will help the experts clarify and settle the apparent congeneric questions of the Charaxinae.

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We are greatly thankful to Drs. A. H. B. Rydon and H. Descimon for supplying us with a number of publications that helped document the present article; to Drs. James G. Sternburg and G. L. Godfrey for dedi-

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PATTERNED PERCHING BEHAVIOR IN TWO *CALLOPHRYS*
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Several species of Nearctic butterflies are well-known for the habitual attachment of their adults to the larval food plant, which serves as a substrate for a behavior popularly called "perching." Notable among these are tree-feeding species such as the nymphalids *Asterocampa celtis* (Boisduval & LeConte) and *A. clyton* (Boisduval & LeConte) on hackberry (*Celtis* spp., Urticaceae) and lycaenids of the taxon *Callophrys* (*Mitoura*), which feed on various Cupressaceae. Except for visits to food sources, adults of these species confine their flight activities to the immediate vicinity of trees, where they are often seen flying out from the branches and returning. Although these habits are often noted in popular studies and regional works, no published research has dealt with their details or nature. The term "perching" has been used as a general category in mate finding in butterflies (Scott, 1973), but such "perching" probably merits distinction from the particular behavior displayed by the aforementioned tree feeders.

The perching species *Callophrys* (*Mitoura*) *siva* (Edwards) and *C. (M.) gryneus* (Hübner) are exclusive *Juniperus* feeders, utilizing a broad spectrum of morphologically and chemically divergent *Juniperus* species that replace each other geographically over a wide area of the Nearctic region (Johnson, 1976). The present paper treats the tree-perching behavior of *C. (M.) siva* and *C. (M.) gryneus* as studied on two of their larval food plants, *J. scopulorum* Sarg. and *J. virginiana* L., respectively. The purpose is to outline the outstanding characteristics of the behavior, consider what environmental stimulus-response relationships are present, and comment on their significance.

Perching Behavior and Environmental Stimuli

Many aspects of insect behavior have been described in the literature and defined into types and categories. Most of these are not applicable

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to specific observations until thorough physiological data is available on a species. Thus, it is best to introduce perching behavior by reviewing literature that concern characteristics of behavior which are observable in the field.

Specific activities of insects result from the continuous "release" of fixed behavior patterns and pattern combinations, which are the insects' response to evolutionarily defined stimuli within its niche. Stimuli may include extrinsic factors (e.g., gravity, light, temperature, humidity, air movements, sound, chemicals, food, mates and other biota) or intrinsic ones (e.g., hormones, feeding rhythms, and mating rhythms). Stimuli are processed into particular released behavior through specific adaptations and interactions of sense receptors. A process may involve a single stimulus and a single receptor, screening of stimuli by a single receptor or balancing of stimuli by several receptors. Generally, many factors, each of which could release such fixed patterns of behavior, are working on many receptors (Jander, 1957).

For the field investigator, one subject for study is the role of light. Two factors may be active, depending on the physiological adaptations of the insects: a relationship to the sun's polarized light (sky light) and/or the position or intensity of the sun itself.

Sky-patterns of polarized light are caused by the varying directions of oscillation of light as it is distributed from the sun. Insects may respond to polarized light directly (von Frisch, 1960), to its different patterns of reflection from the substrate (Kalmus, 1958; Smith & Baylor, 1960) or to both (Jander & Waterman, 1960). Especially important to insects is the relationship in the sky of points of equal degrees of polarization. When connected by hypothetical lines, these points form mathematical planes, and it is to these planes that many insects have become sensorily adapted. In other words, orientation to sky points of certain degrees of polarization causes an insect to react along a certain plane in relation to the source of light and the environment. The most important of these planes for many insects is the plane formed by connecting the points of maximum polarization—70%. This plane runs perpendicular to the straight line from sun to earth, a line which is generally referred to as the electric or "e" vector of light. Reactions and orientations along this perpendicular plane have received much study, and four basic posturing positions have been shown to occur in insects: the parallel position (0° from "e" vector), the vertical position (90° from the "e" vector) and the angular positions ($\pm 45^\circ$ from the "e" vector) (Jander & Waterman, 1960). In polarization-adapted insects, the ratio of occurrence of these positions varies with species and factors

such as temperature (Willington *et al.*, 1951; Henson, 1954) and excitement (Jander & Waterman, 1960).

Reaction to the position and/or intensity of the light source itself involves phototaxis. Insects may be positively or negatively phototactic, and the degree of their response may vary with increase in brightness of the source and/or higher contrast between the source and environment (Robinson & Robinson, 1950; Robinson, 1952), temperature or excitation (Mell, 1954; Marten, 1956), or the physiological tolerances of the sense organs (Verheijen, 1958). These reactions to polarized light or the sun itself can go on simultaneously in the environment.

Gravity is another factor that often cooperates with functions performed by the visual organs (Schwartzkopff, 1965) and is usually sensed through proprioception. It is best to consider the influence of gravity in separate data since it may involve co-actions of various receptors, elicit patterns of response independent of other observations, or even be observed as alternative positive and negative influences in other observed patterns (Markl & Lindauer, 1965). Statistical data that indicate the roles of all of these factors in *Callophrys* (*Mitoura*) behavior were discovered in the present study and are presented below.

METHODS AND MATERIALS

Field-condition studies are neither the only nor most ideal method for studying complex behaviors. The number of inferences that can be drawn concerning possible physiological relationships is limited (Goldsmith, 1965), especially since such inferences depend largely on distinct knowledge of the physiology of the insect's sense organs (Hodgson, 1965). However, appropriately designed experiments are useful for discovering good subject species, basic behavior patterns, and possible parameters for laboratory experiments (Mazokhin-Porshnyakov, 1969, pp. 121 f., 134 f., and 213 f.). In the present study, data samples totaling 471 randomly selected perch positions were gathered in 1973 and 1974. Initially, to compare the behavior of *C. (M.) gryneus* and *C. (M.) siva*, two juniper habitats were selected where sample trees could fulfill the following requirements: nearly equal mean tree height; presence of extremes of height, but similar range; all trees adjacent; and a workable population of *Mitoura*. These sites were: off County Rd. 547, near Lakehurst Naval Air Station, Ocean Co., New Jersey, and Catholic Cemetery, Chadron, Dawes Co., Nebraska. Because of the desire to investigate the possible role of perching behavior in geographic distributions and food plant selection, an extremely northern

(apparently transplanted) *C. (M.) gryneus* colony was studied at New London, Merrimack Co., New Hampshire. Similarly, an effort was made to study the behavior in an arid area, where small juniper morphs occur, but this attempt (by a third co-worker) failed as a result of inclement weather.

The trees numbered at these sites comprised a "base sample" from which trees to be used for treatments could be drawn by random numbers. Because of daily movements by the butterflies in the habitat, treatment trees were actually drawn from a "sub-sample" made up of the number of trees being utilized for perching before each treatment. When the "treatment tree" was selected, the "treatment insect" was designated arbitrarily, and randomness was assured by measuring and recording data on five consecutive choices of perch following the initial flight from the tree. Motivation for flying was either natural movement or from nudging of the appropriate twig by the investigator. Early samples confirmed that such "aided" and "unaided" movements showed no significant mathematical differences in analysis. If the treatment insect changed trees, the change was noted and the sample continued. The time between tree changing allowed study of the types of trees chosen for perching. Accordingly, a "selected mean tree height" was calculated for each study area based on the number of times certain trees were chosen for perching. If an insect flew out of the area and the five-choice treatment could not be completed, the remaining perches were considered to be zero for all measurements and observations. Perch locations were designated by lifting a colored loop of string or wire to the perch site; tree and perch heights were measured with a graduated measuring rod. The measurement method was tested against known heights by the "t" test and showed no significant differences when used to the nearest centimeter up to 4 m. Above this height, measurements were rounded to the nearest decimeter. The latter method had to be used only in the supplementary samples mentioned below.

For comparison, supplementary areas (medium-size trees at Tuckerton, New Jersey and tall trees at Blackbird State Park, Delaware) were sampled, some by the above method; other data were culled from earlier observations at Long Pine Recreation Area, Brown Co., Nebraska. These data were not used in the random sample analysis of measurements, but were enumerated.

In this paper, any statistical value listed without an accompanying probability was not significant above $p = 0.20$, except in the few cases where extraordinarily high χ^2 values were significant beyond question.

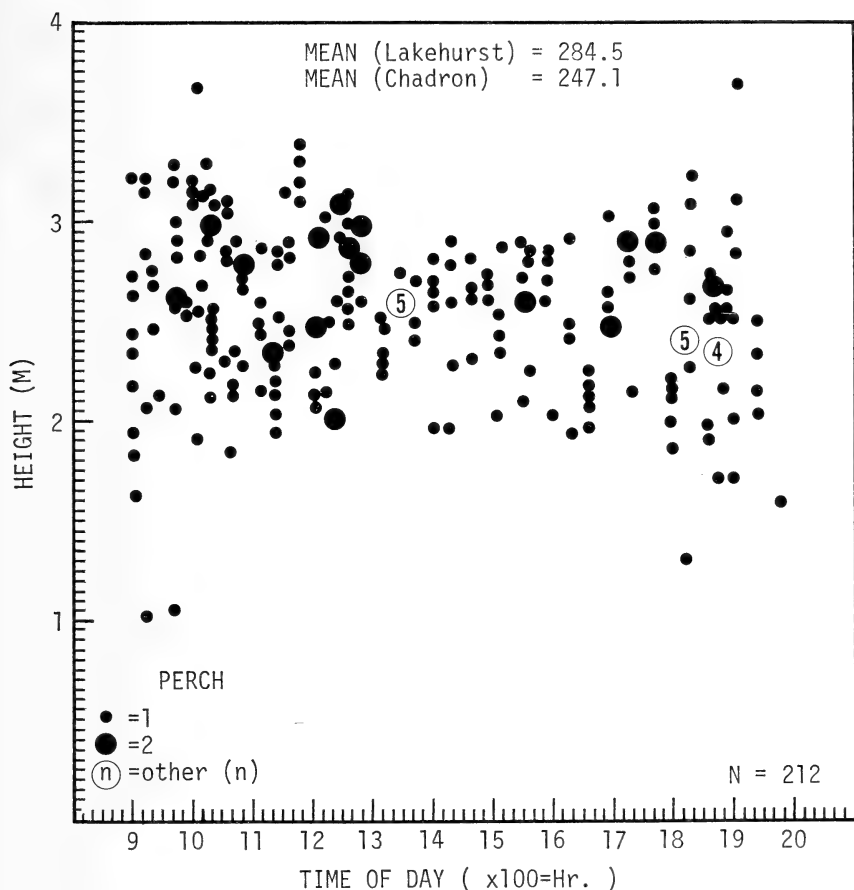


Fig. 1. Heights of perch plotted against time of day at Lakehurst and Chadron.

RESULTS

Perch Location

Perch location and sunlight. The role of sunlight showed general and specific consequences in the behavior. At Chadron and Lakehurst, of 239 perches recorded, only 3 were not in direct sunlight ($\chi^2 = 226.8$), and at New London this ratio was 232/1 ($\chi^2 = 229.0$). These samples were always made in sunny or partly sunny weather, and although some activity by the insects occurs during overcast warm weather, it may involve stimulus-response mechanisms that are not comparable to those subject to this investigation.

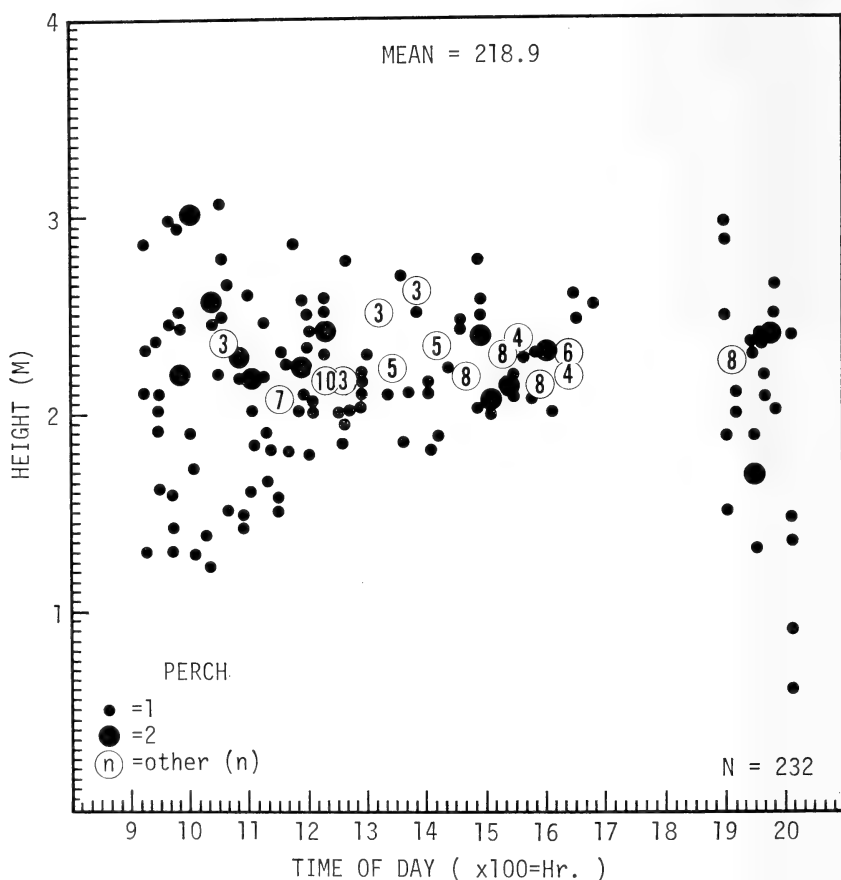


Fig. 2. Heights of perch plotted against time of day at New London.

Heights of perch were plotted against time of day as in Figs. 1 and 2. The dots form an "hourglass-on-its-side" configuration characterized by greater dispersal of height of perch in morning and late afternoon-evening than at midday. This gradual shift in degree of dispersal was confirmed by correlation coefficients (cf. Fig. 3). These were also used to designate three "periods" apparent in the behavior: morning "expansion" (0700-1245 hr), midday "compression" (1245-1445 hr) and late afternoon-evening "expansion" (1445-1900 hr) [all ST]. These three periods are significant because they demonstrate changes in the behavior in relation to the angle of the sun, which will be discussed further.

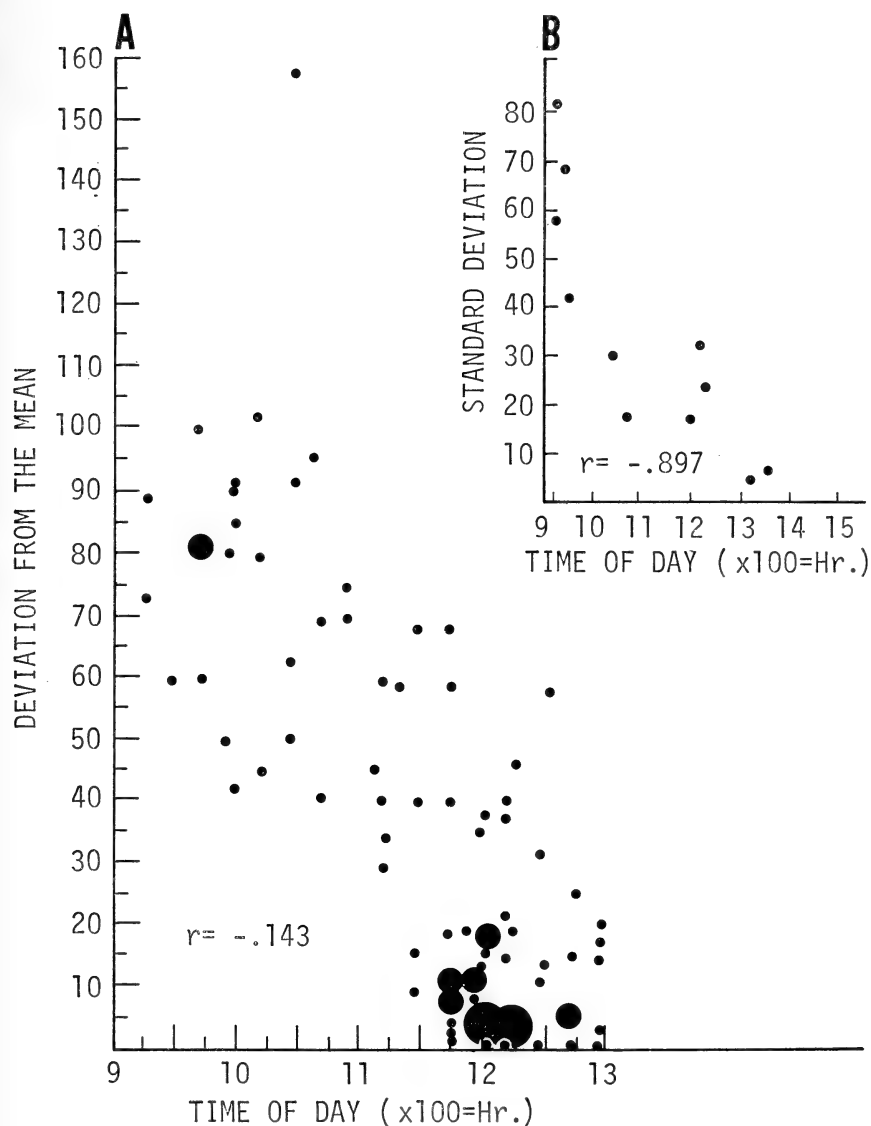


Fig. 3. Correlation coefficients. (A) Deviation from the sample mean of each perch at New London (morning expansion period) correlated with time: $r = -.143$; $p = .10-.05$; $n = 145$. Small dot = 1; medium dot = 2; large dot = 3. (B) Standard deviation of each treatment from the sample mean at Chadron (morning expansion period) correlated with time: $r = -.897$; $p = .001$; $n = 11$. Not shown: deviation from the sample mean of the mean perch height of each treatment at Chadron (evening expansion period) correlated with time (scaled opposite direction): $r = .478$; $p = .05$; $n = 20$.

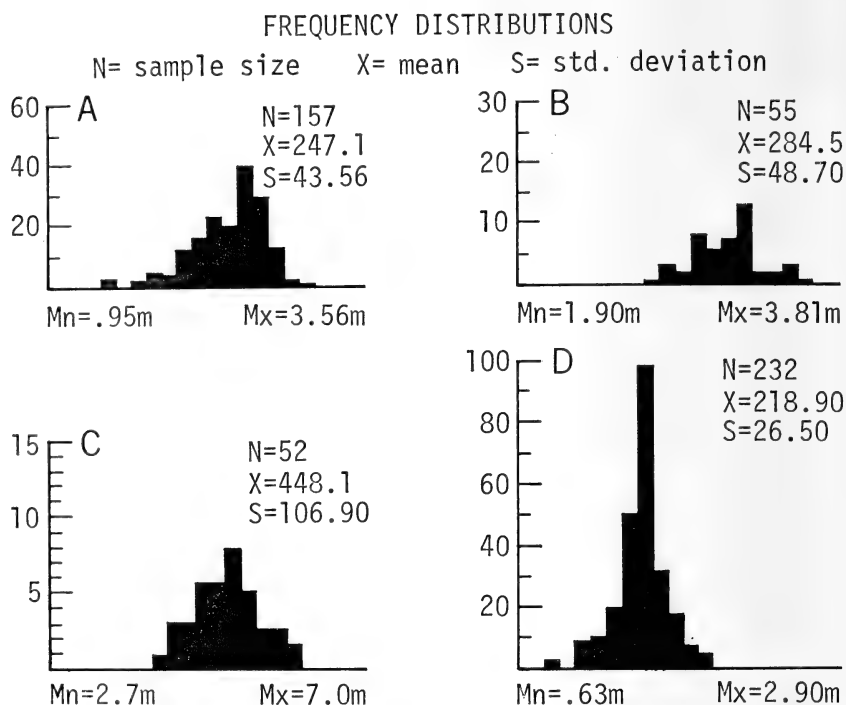


Fig. 4. Frequency distributions of heights of perch: A, Chadron; B, Lakehurst; C, Long Pine; D, New London. Lakehurst, Chadron, and New London: 20 categories, each 20 cm. Long Pine: 20 categories, each 35 cm. Maximum and minimum perch height are indicated.

Perch location and height. Frequency distributions of heights of perches (Fig. 4) skewed right, which indicated preference for height. This indication was further confirmed by calculation of "selected mean tree height" for each sample area, in which the height of each tree was multiplied by the number of times it was selected for perching and the mean was computed. These were always higher than the mean tree height of the sample. Furthermore, frequencies of heights of individual trees selected for perching, plotted against availability of these heights in the sample (Fig. 5), showed similar preference. Together, these data indicate that choice of perch as a whole forms a gradually shifting and somewhat symmetrical pattern in relation to time of day and is distinctly preferred for heights.

Perch location and tree surface. Percent of height of tree used per time of day was evaluated as in Figure 6. The entire figure (dots and hatches) shows the frequency of use of heights (in percent) for

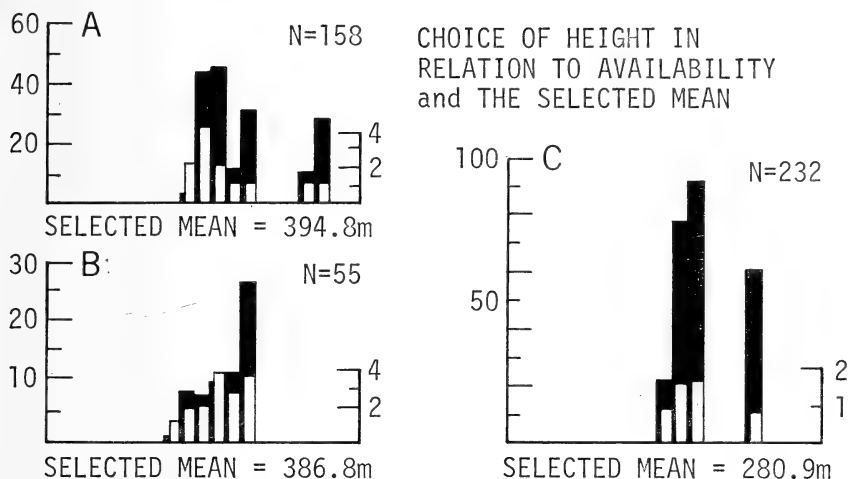


Fig. 5. Frequencies of heights of individual trees selected for perching plotted against availability of these heights. Left scale (black frequencies): height category chosen for perching. Right scale (hatched frequencies): number of trees in the sample of each category. (A) Chadron, 20 categories, each 20 cm. (B) Lakehurst, 20 categories, each 20 cm. (C) New London, 20 categories, each 17 cm. Trees in the base sample not chosen for perching are excluded. "Selected mean perch height" of each sample is indicated; the mean of—the height of each tree times the number of times chosen for perching.

the entire day; the stippled areas show morning and late afternoon-evening expansion periods, and the hatches show the midday compression period. The forming of two separate "humps" indicates that two interrelating stimulus factors are probably involved. Use of the tree in the compression period is uniformly undispersed (as also apparent on the perch height per time of day (Figs. 1, 2)) and occurs mostly high in the trees. This compression period occurs when the sun is high above the sample area and the plane of reaction to 70% polarized light is distributed horizontally along the tops and ascending angles of the trees. Height-use of the trees in the two expansion periods, however, forms two humps (there is some variation in the two samples), with the second hump being lower on the trees. The expansion periods occur when the sun is low in the sky and the plane of reaction to 70% polarized light is distributed vertically over the sides and ascending angles of the trees. Actually, this plane is continually changing, rotating from the vertical obliquely to the horizontal and back as the day continues. Apparently this rotation dictates the configuration of the perch locations through the day.

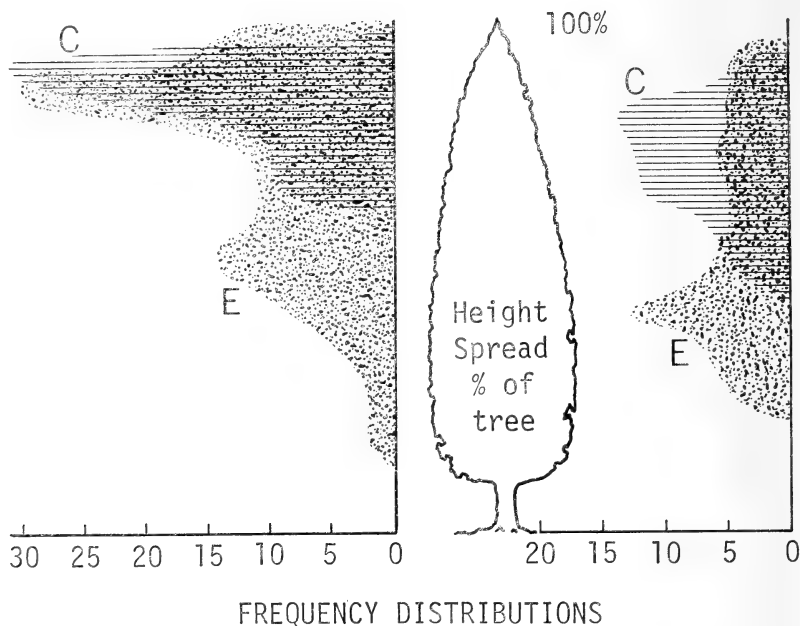


Fig. 6. Evidence of two factors influencing perch height: percent height of tree utilized per time of day. See text for discussion.

Behavioral differences between the species. It is especially interesting that the samples of *C. (M.) siva* in Nebraska and *C. (M.) gryneus* in New Jersey could be lumped together for this study. The study areas were chosen with this in mind. Early comparisons of “heights of perch”/“heights of tree” for a similar time period showed no significant difference in the behavior of the two species in the nearly duplicate habitats ($t = 1.98$; $p = 0.05$; $n = 100$).

Summary. The trees at Chadron and Lakehurst were extremely variable in height and often located meters apart. At New London all the trees were nearly the same height (except for one a bit higher), and all were immediately aside one another. This difference may be reflected in the respective patterns of selection of perch. There was little distance for flight between the trees at New London, and thus, perhaps, occurred the higher frequency of changing trees, the marked tendency to choose a perch relatively near the height of the former, and the tendency to ascend higher when the single taller tree was reached. Despite these variations, the general information of the “hour-glass-on-its-side” configuration is most compatible, in both areas, with

the hypothesis that the shifting plane of reaction to polarized light, vertical to horizontal to vertical and the position of the sun itself form the basic influences on the behavior.

Perch Posture

Posturing positions. Insects specifically adapted to polarized light and/or phototactic stimuli generally display certain fixed postures when they are stationary. Gotz (1936) and von Buddenbrock (1917) demonstrated a "turning tendency" that follows locomotion, in which the insect moves to assume its "stable" position of posture in relation to the sun. These two *Callophrys* (*Mitoura*) species displayed the four basic positions mentioned in the Discussion. Such positions have been demonstrated in a number of other insects, all of which are polarized-light adapted. Willington *et al.* (1951) and Henson (1954) showed the occurrence of these positions in particular frequencies in larvae of Lepidoptera. They were also demonstrated in *Bidessus* and *Geotrupes* (Coleoptera) by Birukow (1953) and Jander & Waterman (1960), respectively. Jacobs-Jessen (1959) showed that in *Halictus* (Hymenoptera) only two postures (0° and 90°) occurred, the two 45° postures evidently disappearing with excitation, the role of which was also confirmed by Jander & Waterman (1960). Similarly, effects of temperature or excitation have been shown in the aforementioned studies of Lepidoptera larvae.

In *Callophrys* (*Mitoura*), the 45° posture was only noted early in the periods and then disappeared. The gross ratios of 0, 45, and 90° postures were: Chadron—19/3/48; Lakehurst—23/4/17; Chadron and Lakehurst—42/7/65; Lakehurst and two supplemental sites—30/4/23; and New London—71/5/148. The 0° number is divided between the anterior and posterior toward the sun for these respective localities as follows: 6/13, 9/14, 15/27, 17/13, and 35/36.

It is clear that a discrepancy occurs if the Chadron and Lakehurst calculations are lumped together as was shown reasonable with perch location. This may not be due to species difference but because all Lakehurst (and supplemental) populations were morning expansion-period samples. Dropping the 45° posture, the combined Lakehurst and Chadron ratios of 90 to 0° posture is ca. 3:2. For New London this ratio is ca. 2:1. Thus, the difference, considering Lakehurst, may indicate that additional data would show certain postures more prevalent at certain times of day.

A number of χ^2 tests were performed on 1×2 , 1×3 , and 1×4 combinations of data from these sites as well as within and between

species. It is not useful to state each calculation here except to mention that all showed a significance of at least $p = 0.05$ — $p = 0.10$ to the extreme categories—0 and 90° . Similarly, the dominant frequency of 90° when compared with the sum of all others was $\chi^2 = 23.14$, $p = 0.001$ at New London and $\chi^2 = 9.78$, $p = 0.01$ – 0.001 at Chadron.

Special mention should be made that no locomotion was evident by these insects at the perch. Of the 471 perch choices in this study, only 6 insects showed locomotion at the perch. Thus, any "turning tendency" of movement necessary to assuming the stable posture must occur in flight before alighting.

Repetition of perch posture. There was a definite tendency for postures to repeat, at least for a brief period. This was investigated by creating an "index of repetition (IR)" and "index of nonrepetition (INR)." Each five-choice sample was evaluated as to the total combinations of repetitions or changes. Each change or repetition was given a value of $\frac{1}{5} \times$ the number of figures in the combination. (In a 90° , 90° , 90° , 0° , 0° sample the repetition value would be $\frac{2}{5} + \frac{2}{5} + \frac{3}{5} + \frac{2}{5}$ and the change value would be $\frac{2}{5}$.) These were then multiplied by 2 and added in decimals. The results were as follows: Chadron ($n = 47$)—IR = 15.4, INR = 6.6 ($\chi^2 = 3.52$, $p = 0.05$); Lakehurst ($n = 51$)—IR = 14.4, INR = 10.0 ($\chi^2 = 0.80$); and New London ($n = 226$)—IR = 76.2, INR = 34.5 ($\chi^2 = 15.62$, $p = 0.001$). There is a more graphic difference at New London, possibly because of the closeness of the trees in the sample.

There was little evidence that the insects (as commonly observed in the popular literature) often return to the exact perch from which they flew. Of the 471 perches in the sample, only 11 indicated such behavior.

Thermodynamics and perch posture. Since the physiological function of "sunning of the wings" in butterflies is well-known (Clench, 1966), the high frequency of the 90° angle position has an obvious thermodynamic value. For *Mitoura*, sunning is accomplished by closing the wings above the thorax and thus displaying one ventral primary and secondary to the sun.

Perch position and gravity. The investigation of positive and negative geotaxis in these insects was hampered by the subjectivity of the observations. At first, three positions were noted in samples—head obviously upward, head obviously downward, and insect horizontal. The latter was too subjective and was abandoned, which resulted in arbitrary designation of one of the first two. The results suggest that the

positioning of the head occurs at random and alternates independently of the angle of the posture: Chadron—(method abandoned); Lakehurst and two supplemental—head up = 33, head down = 22 ($\chi^2 = 2.20$, $p = 0.20-0.10$), IR = 16.6, INR = 4.2 ($\chi^2 = 7.40$, $p = 0.01$); and New London—head up = 102, head down = 113 ($\chi^2 = 0.56$), IR = 73.9, INR = 16.5 ($\chi^2 = 33.96$, $p = 0.001$).

Other observations. Marked lethargy was shown by the insects in early morning and late evening, with refusal to move even upon touching. Borgo, in Delaware and New Jersey, noted individuals very low in the trees (0647–0702 EST: 0.45–1.95 m) and some covered with dew. These all later activated for daytime perching. Similarly, Johnson, in Nebraska, noted refusal of the insects to fly at dusk (ca. 7 pm MST). Behavior that suggests oviposition was also observed by Johnson. The insects favored no particular part of the tree, occurring on upper branches and on twigs near the ground. Females clung to the twig, with head upward (angle posture variable), and arched the abdomen in successive movements toward the undersurface of the twig. No oviposition was ever observed. Distinct avoidance behavior was noted where a cultivated spruce tree (*Abies* sp., Pinaceae) occurred in the center of the Chadron habitat. On two occasions butterflies flew to it but veered off to perch on a nearby juniper. Other butterflies found on the junipers included *Cynthia cardui* (Nymphalidae), *Asterocampa celtis* (Nymphalidae), *Cercyonis pegala olympus* (Satyridae), and *Strymon melinus* (Lycaenidae). Each of these flew out of junipers as *Callophrys* (*Mitoura*) were being studied.

SUMMARY AND CONCLUSIONS

The data in this study strongly suggest that the perching behavior of *C. (M.) siva* and *C. (M.) gryneus* is distinctly patterned and not simply a random usage of the tree. This has strong implications with regard to all *Callophrys* (*Mitoura*) species that feed on Cupressaceae, since their behavior is generally considered similar by lepidopterists. The statistical data on changes in the behavior with time of day and on perching postures support the assumption that the insects orient to interactions of polarized light and the position of the sun. The behavior is distinctly preferred for height, and taller trees are most often selected for perching.

These species are suggested to the physiologist for laboratory experiments to examine in greater detail the precise environmental relations of the behavior and the stimulus-response mechanisms of the insects.

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HILLTOPPING IN LEBANON

Considering the extensive literature on hilltopping (Shields (1967, J. Res. Lepid. 6: 69-178) gives nearly 200 references), it seems worthwhile to give a few notes from Lebanon on the topic. I do not recollect having seen previous references from the Levantine area.

After collecting the localized *Euchloe belemia* Esper (10 km E of Saida, 21 March 1972) for a few hours, I ascended a small rounded hillock with typical garrigue vegetation. For more than 15 min. one *Papilio machaon syriacus* Verity, two *Vanessa cardui* Linné and one *Vanessa atalanta* Linné were observed circling the top. One or more might briefly settle, but mostly all four were on the wing. There was little beating of the wings, most movement being a strong glide. No other butterflies were seen on the hilltop, and the species in question were not noted elsewhere in the vicinity. The weather was fine, with a breeze from the west.

A large and fresh male of *Iphiclides podalirius virgatus* Butler was caught on a small summit surrounded by a precipitous drop of more than 200 m on three sides, the eastern side being somewhat gentler (Cedar Mountain, 1,900 m, 17 July 1974). The specimen hardly moved its wings while gliding on the updraft produced by a breeze from the west. It must have come from Bscherré village, some 300 m lower, where the closest breeding colony is located.

In the above cases I was struck by the apparent "*joie de vivre*" of the ebullient circling and by the method of flight, which differed so much from that ordinarily seen. Two rare species, *Papilio alexanor maccabaeus* Staudinger and *Elphinstonia charltonia penia* Freyer, are nearly always found about the summits of stony outcrops. Their flight in such situations is quite normal, however, which may simply indicate the presence of their food plants—so far unknown in Lebanon.

I have little doubt that hilltopping is more common in the Middle East than the lack of recorded evidence suggests. The places where these singular aerobic displays are performed are otherwise so unattractive that no entomologist would pay them a visit.

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OBSERVATIONS ON HOST PLANT RELATIONSHIPS AND
LARVAL NUTRITION IN *CALLOSAMIA* (SATURNIIDAE)¹

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The genus *Callosamia* Packard is comprised of three closely related species that occur in eastern North America. *Callosamia promethea* (Drury) ranges from Canada to Florida and west to the Great Plains and accepts a wide range of hosts. *Callosamia angulifera* (Walker) occurs east of the Mississippi River, most commonly from Pennsylvania to Georgia, and feeds exclusively on tuliptree (*Liriodendron tulipifera* L.). *Callosamia securifera* (Maassen) is found only in swamps and pine woods in the coastal areas of the Southeast (Peigler, 1975) and feeds exclusively on sweetbay (*Magnolia virginiana* L.).

The purpose of the present paper is to discuss briefly some of my observations regarding the hosts of these moths. Because the Saturniidae are popularly reared, I have attempted to discover alternate foods for the two monophagous species so that they might be reared where the preferred foods are not available. Information is also presented on the acceptability of these host plants as a function of larval age.

Host Plants of *Callosamia promethea*

The wide variety of host plants of *C. promethea* accounts for the much wider geographical distribution of this species when compared with its congeners. This variety is also a factor in the ability of *C. promethea* to exist in many different types of habitat. Although the host range is comparatively wide, a preference for Lauraceae is evident, and no conifers or monocots are known hosts. Most of the *C. promethea* foods are aromatic plants such as sassafras (*Sassafras albidum* (Nutt.) Nees.), horse sugar (*Symplocos tinctoria* (L.) L'Her.), sweetgum (*Liquidambar styraciflua* L.), spicebush (*Lindera benzoin* (L.) Blume) and wild black cherry (*Prunus serotina* Ehrhart). Such plants may possess an important olfactory stimulus which initiates oviposition by females or feeding by newly eclosed larvae.

Callosamia promethea on horse sugar in coastal South Carolina was thought to represent a host-specific population (Ferguson, 1972), such as the population on lilac (*Syringa vulgaris* L.) around Milwaukee,

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Wisconsin. However, I have found cocoons in the former area on wild black cherry. I have also found cocoons on horse sugar and other more common hosts in Oconee Co., South Carolina. It is interesting to note the corresponding disjunct ranges of *C. promethea* and horse sugar (Radford *et al.*, 1964) in South Carolina, where both occur in the mountains and near the coast but are absent for over 100 mi. between. *Callosamia promethea* is not recorded on horse sugar anywhere else, except where I have found it in Brunswick Co., North Carolina.

Certain hosts given by Packard (1914) and cited by later authors need to be verified and may have been based on cocoons of larvae that did not spin on the actual food plant. These are barberry (*Berberis*), maple (*Acer*), azalea, birch (*Betula*) and arbor-vitae (*Thuja*), the latter two seeming especially questionable. I have tried to rear Pennsylvania *C. promethea* on azalea and *Acer rubrum* L., but the larvae died in first instar.

An unpublished host of *C. promethea* is sweetbay. Dale Schweitzer (pers. comm.) found *C. promethea* cocoons on sweetbay in Longwood Gardens, Kennett Square, Pennsylvania, where the tree is not native, and in the pine barrens of Burlington and Atlantic counties, New Jersey. However, I have tried several times to rear *C. promethea* (Pennsylvania stock) on sweetbay; the larvae always grew slowly and died within 15 days, usually in the second instar.

Host Plants of *Callosamia angulifera* and *C. securifera*

A brood of *C. angulifera* ♂ × *C. securifera* ♀ was reared on tuliptree and sweetbay, the two respective parent foods. The larvae on tuliptree matured faster and spun their cocoons almost two weeks before their siblings on sweetbay, although the size of adults in both groups was the same. The physiological advantage of tuliptree over sweetbay was also shown in broods of pure *C. angulifera* and *C. securifera*. Newly hatched larvae did not survive on the host plant of the opposite species, although some *C. securifera* were once reared from ova to adults on tuliptree (Jones, 1909). Later instar larvae of *C. angulifera* completed their larval development on sweetbay in most cases. However, *C. securifera* that fed for the first two weeks on sweetbay readily completed their larval life on tuliptree. For comparison, larvae from these same broods were reared exclusively on their preferred hosts.

In addition to the trials of *C. angulifera* and *C. securifera* on their two hosts, these species were tested on other species of Magnoliaceae, both American and Oriental. Newly hatched larvae of both species

were placed on potted seedlings or rooted cuttings of the two American plants, *Magnolia grandiflora* L. and *Illicium floridanum* Ellis., and the Asian *M. stellata* (Sieb. & Zucc.), *M. soulangeana* (*M. denudata* Desrouss. \times *M. liliflora* Desrouss.), *Illicium anisatum* L. and *Kadsura japonica* (L.) Dun. All except the first of these plants have tender leaves. The larvae fed sparingly, wandered and, in all cases, died within a few days in the first instar. Unfortunately, none of the several American species of deciduous *Magnolia* were available.

The results obtained with these substitute hosts imply the lack of a phagostimulant rather than some essential nutrient(s). It is possible that the larvae would survive on such plants if they would feed freely. No evidence of toxicity was observed.

Further testing the following year gave an alternate host for *C. securifera*. Ten newly hatched larvae were put into a jar with leaves of wild black cherry, *Magnolia grandiflora*, sweetgum, buttonbush (*Cephalanthus occidentalis* L.) and more of the Magnoliaceae tried earlier. Again larvae fed sparingly and wandered, and all but two died within three days. Of the two that remained, one was a first instar which ate buttonbush and the other was a second instar which fed on *M. grandiflora*. Sweetgum also showed that feeding had occurred on it. Fresh leaves of buttonbush, *M. grandiflora*, and sweetgum were offered to these larvae, and they chose sweetgum. Soon after, they were sleeved outdoors on sweetgum. The smaller larva, which had eaten buttonbush, died in the third instar. The other larva produced a slightly undersized female moth the following month. If one attempts to rear *C. securifera* on sweetgum, most or all of the larvae would be expected to die early. I do not believe this tree ever serves as an alternate host in nature.

Lepidopterists have found that *C. angulifera* will sometimes accept spicebush, sassafras, and wild black cherry (Eliot & Soule, 1902). However, since these plants are inferior substitutes for tuliptree, larvae on them would probably not grow as rapidly or as large. I seriously doubt that these alternate hosts are ever utilized in nature.

DISCUSSION

The Magnoliaceae is a very old angiosperm family with fossils dating to the Cretaceous period. The widest ranging species of the family in North America is tuliptree, the food of *C. angulifera*. The nocturnalism of *C. angulifera* suggests that it is closest to the ancestral form of the genus. Tuliptree is the best choice for rearing any *Callosamia* hybrid and is presently the only "common denominator" food for all three

species. Therefore, it is probable that tuliptree is the original food for the genus.

ACKNOWLEDGMENTS

I am grateful to Drs. Raymond Noblet and G. R. Carner, entomology professors at Clemson University, for much helpful criticism on the research and the manuscript.

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TIME VARIATIONS OF PUPAL STAGE OF *EUPACKARDIA CALLETA* (SATURNIIDAE)

In December 1971 a friend presented me with 16 pupae of *Eupackardia calleta* (Westwood) which he had found while trimming shrubbery in his yard. These pupae had undoubtedly come from the same egg hatch, probably in the early fall of 1971, because all were found on the same bush and several on the same limb. I was never able to find out from what plant he collected the pupae. All the pupae appeared to be alive and in good condition.

Eight of the pupae were sent to a friend and eight I kept for myself. Of the eight sent away two males emerged in September 1972, also one pupa produced several parasitic flies during the same month. In March 1973 one female emerged and one pupa had died and dried up. I have no record as to what has happened to the other three remaining pupae.

A record of the eight pupae I kept for myself is as follows. One male emerged in August 1972 and another male in September 1972. In March 1973 one female emerged and on 19 August 1974 one male emerged. It was at this time, August 1974, that I noted that one of the four remaining pupae had died. On 1 September 1975 one male emerged and on 25 September 1975 a large female emerged. Of the six adults which have emerged the development time from egg to adult ranged from approximately 1-4 years. The remaining pupa recently has lost some of its weight and probably has died.

All of my pupae have been kept in the same environmental conditions, and all of the adults have been normal and healthy.

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A REVISION OF THE GENUS *DUNAMA* SCHAU (NOTODONTIDAE)

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Several years ago some moths reared from larvae from Mexico found on importations of *Chamaedorea*, a genus of small palms, were sent to me for identification by Mr. D. R. Johnston, San Antonio, Texas. The adults proved to be a new species of the monobasic genus *Dunama* Schaus of the family Notodontidae. A search of the collections of the Neotropical notodontids in the U.S. National Museum and of the British Museum (Natural History) revealed three other species belonging to the genus. One of the three is another undescribed species from northern South America. Of the three described species, one had been described twice, but the synonymy had not been recognized. The synonyms were described in different genera, and each subsequently had been moved to a different genus. All the generic assignments and transfers, except of the type-species, were incorrect. Five species of the genus *Dunama* are now recognized.

Until recently the only known food plant was a single species of *Chamaedorea*. This plant genus is composed of a large number of species, and some have rather restricted or limited distributions. It is possible, therefore, that other species of *Dunama* may be recognized when some of the other species of *Chamaedorea* are examined for larvae or when collecting at light for adults is accomplished in the vicinity of such plant species. In 1971, *Dunama angulinea* (Schaus) was reared from larvae found feeding on bananas in Panamá by Mr. C. S. Stephens.

Descriptions of the larvae are not included in this paper. They will be described in a separate paper by D. M. Weisman.

Dunama Schaus, 1912

Ann. and Mag. Nat. Hist., ser. 8, vol. 9, p. 52.

Type-species: *D. angulinea* Schaus, monotypy and original designation.

Diagnosis: Small to moderate-sized notodontid moths, length of forewing 10–22 mm; male antennae bipectinate for $\frac{3}{4}$ length, pectinations of fifth or sixth segment longest, decreasing to simple at apical fourth, female antennae simple, scale tuft of first antennal segment small in both sexes; palpi upcurved to near middle of frons, second segment long, third segment small not more than $\frac{1}{2}$ length second segment, slightly decumbent; tongue well developed; ocelli absent. Thorax without prominent tufts, vestiture rather loose; abdomen without tufts. Forewing with slender accessory

cell; M_1 from bottom third of accessory cell; hindwing with Sc from about middle of cell, diverging from R_s , nearly straight; R_s and M_1 connate from upper angle of cell; M_3 and Cu_1 connate from lower angle. Male genitalia distinctive (Figs. 10–14), uncus variable, an ovoid lobe or bifid; socii well developed, sclerotized curved processes; valves with costal margin sclerotized, ventral margin mainly membranous, but sometimes toothed near end of sacculus; juxta scarcely developed, fused with bases of valves when present; aedeagus moderately long, apical half heavily sclerotized and usually somewhat reduced in diameter toward apex, shaft usually with dorsolateral spines and processes or a dorsal plate near middle; eighth sternite with caudal margin produced into heavily sclerotized process, sometimes bifid. Female genitalia (Figs. 15–18), rather reduced; ovipositor lobes and ninth segment sclerotized; some ostial sclerotizations; corpus bursae small, membranous, without signa.

This genus has been placed near *Disphragis* Hübner, but it is doubtful that it belongs to the Heterocampini. I believe it to be a member of the tribe Nystaleini, subfamily Notodontinae. It does not agree completely with the definition of that tribe by Forbes (1948, p. 206), but that definition was based primarily on a few North American genera and species and undoubtedly will need to be modified when the much larger group of Neotropical elements are studied. The present classification of the Neotropical notodontids is very unsatisfactory. Forbes (1948, p. 203), stated: "The classification of the North Temperate fauna is fairly well understood, but the much larger and richer tropical fauna is in complete confusion." The almost complete lack of knowledge of the immature stages of the Neotropical notodontids presents a serious complication to the development of a more satisfactory classification of the family.

KEYS TO THE SPECIES

MACULATION AND COLORATION

1. Males 2
 –Females 6
2. Vertex of head, thorax and basal part of forewing with conspicuous areas of pale straw yellow; forewing with distinctive, slightly oblique, black bar from basad of reniform spot to near base of inner margin *D. tuna* (Schaus)
 –Head, thorax and base of forewing mostly dark brown; forewing with median part of antemedial band at most a dark triangular spot only slightly longer than wide 3
3. Subterminal transverse shade of forewing absent; forewing with a faint longitudinal pale streak present through cell from base of wing nearly to termen *D. ravistriata*, n. sp.
 –Subterminal transverse shade of forewing present, especially in anterior half of wing; forewing with longitudinal pale streak absent, or present only distad of reniform spot 4
4. Longitudinal pale streak of forewing weak, but present distad of reniform spot *D. angulinea* Schaus
 –Longitudinal pale streak of forewing absent 5
5. Costal area of forewing distad of reniform spot distinctly darker than remainder of distal part of wing; median transverse band immediately distad of antemedial band paler at middle than near inner margin *D. claricentrata* (Dognin)
 –Costal area of forewing distad of reniform spot if darker than remainder of distal part of wing only slightly so; median transverse band immediately distad of antemedial band not especially paler at middle *D. mexicana*, n. sp.
6. Forewing with vague to distinct pale longitudinal streaks distad of reniform spot 7

- Forewing with pale longitudinal streaks absent distad of reniform spot *D. mexicana*, n. sp.
7. An oblique black bar present from reniform spot to near base of forewing *D. tuna* (Schaus)
- Forewing with at most a dark triangular spot, slightly longer than wide, from near middle of antemedial band 8
8. Median part of dorsum of thorax with an oval spot of pale scales *D. angulinea* Schaus
- Median part of dorsum of thorax uniformly dark *D. ravistriata*, n. sp.

ABDOMINAL SCLERITES AND MALE GENITALIA

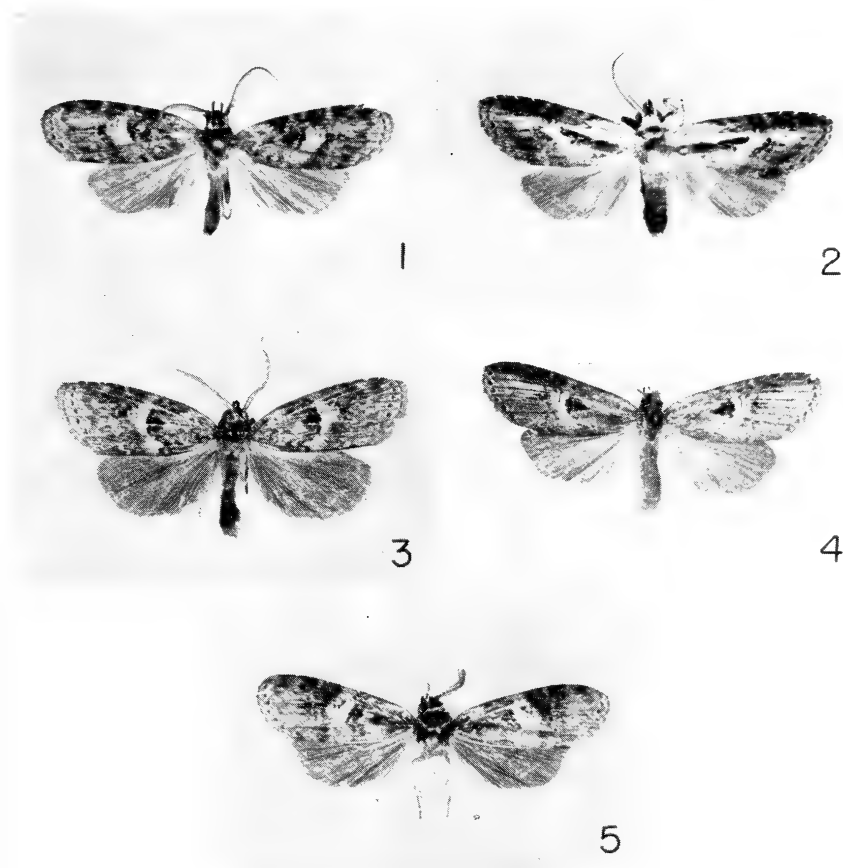
1. Males 2
- Females 6
2. Sclerotized process of eighth abdominal sternite bifurcate 3
- Sclerotized process of eighth abdominal sternite not bifurcate 4
3. Process of eighth abdominal sternite with toothed lateral flanges at base of bifurcation *D. tuna* (Schaus)
- Process of eighth abdominal sternite without lateral flanges at base of bifurcation *D. angulinea* Schaus
4. Uncus bifid; ventral margin of valves normal 5
- Uncus clavate, the lateral margins more heavily sclerotized than middle; ventral margin of valves heavily sclerotized and irregularly toothed near end of sacculus *D. claricentrata* (Dognin)
5. Uncus Y-shaped, the lobes slender, slightly knobbed at apices; aedeagus with two large elongate, spinelike dorsolateral processes from middle of shaft *D. mexicana*, n. sp.
- Uncus with two stout slightly divergent lobes; aedeagus with one small blunt spinelike process near distal $\frac{1}{5}$ of shaft *D. ravistriata*, n. sp.
6. Posterior margin of ninth abdominal tergum irregularly toothed; lateral angles of eighth abdominal sternum produced into flat, sharp-pointed triangular processes *D. mexicana*, n. sp.
- Posterior margin of ninth abdominal tergum and lateral angles of eighth abdominal sternum not so modified 7
7. Posterior margin of eighth sternum V-shaped and slightly to moderately irregularly toothed *D. ravistriata*, n. sp.
- Posterior margin of eighth sternum transverse or slightly convex and slightly emarginate in middle, margin not toothed 8
8. Sternum of ninth abdominal segment a broad sclerotized band nearly uniform in length basad of ovipositor lobes *D. tuna* (Schaus)
- Sternum of ninth abdominal segment membranous at middle third basad of ovipositor lobes *D. angulinea* Schaus

Dunama angulinea Schaus

Figs. 1, 7, 10, 15

Dunama angulinea Schaus, 1912, p. 52. Draudt, 1932, p. 981. Gaede, 1934, p. 263.

Diagnosis: Size, forewing length, ♂ 10-13 mm, ♀ 12-15 mm. The pattern of maculation (Fig. 1) is similar to that of *Dunama claricentrata* (Dognin) and *D. mexicana*, n. sp. in the males. Females are not so contrastingly marked and resemble that sex of *D. mexicana* and *D. ravistriata*, n. sp., but the disc of the thorax has a tuft of pale scales not found in *D. mexicana* and the basal area of the forewing does not have a longitudinal ray of pale scales as in *D. ravistriata*. Both sexes are somewhat variable in the pattern of maculation. The most reliable characters for species identification are shape of the eighth abdominal sternite of the male



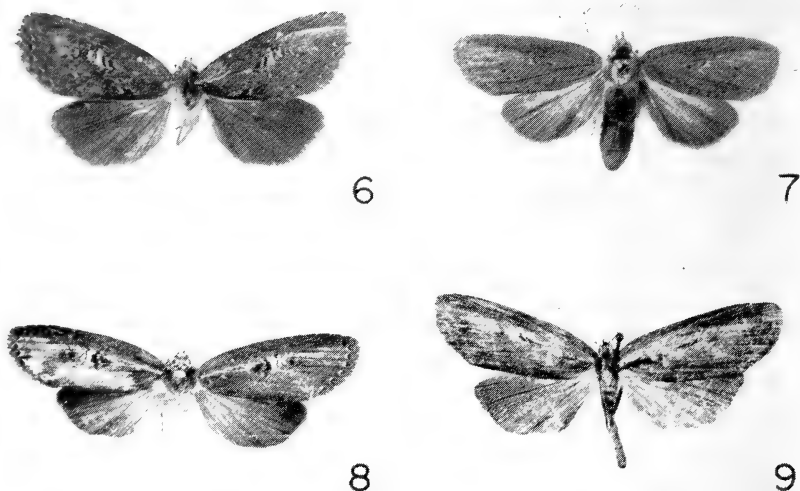
Figs. 1-5. Dorsal view of adult males of *Dunama* species: 1, *angulinea*, holotype male, Guápiles, Costa Rica; 2, *tuna*, holotype male, Colombia; 3, *mexicana*, holotype male, México; 4, *ravistriata*, paratype male, Teffé, Amazonas, Brazil; 5, *claricentrata*, holotype male, French Guiana.

(Fig. 10) and the genital structures of the female (Fig. 15). The bifurcate process of the eighth abdominal sternite of the male lacks toothed, lateral flanges as in *D. tuna* (Schaus). The female genitalia are similar to those of *D. tuna*, but the ninth abdominal sternite is membranous at middle basad of ovipositor lobes, not sclerotized as in *D. tuna*.

Type: The male holotype is in the U.S. National Museum. It was collected at Guápiles, Costa Rica.

Distribution: Twenty-nine examples, 14 ♂ and 15 ♀, have been studied. They are from the following localities: MÉXICO: Teapa, Tabasco. GUATEMALA: Cayuga; Quirigua. COSTA RICA: Guápiles; Sixaola River. PANAMÁ: Changuinola; Paraiso, C. Z.

Food plant: This species has recently been reared from bananas in Panamá, but it does not seem likely that the banana plant is the normal host. If that were so,



Figs. 6-9. Dorsal view of adult females of *Dunama* species: 6, *mexicana*, paratype female, México; 7, *angulinea*, female, Changuinola, Panamá; 8, *ravistriata*, paratype female, Pará, Brazil; 9, *tuna*, female, paralectotype of *sagittula*, Río Toche, Colombia.

considering the attention given to insects on that crop, surely larvae would have been discovered long ago.

Dunama tuna (Schaus), n. comb.

Figs. 2, 9, 11, 18

Heterocampa tuna Schaus, 1901, p. 304.

Disphragis tuna (Schaus), Draudt, 1932, p. 972. Gaede, 1934, p. 261.

Naduna sagittula Dognin, 1914, p. 22. [New synonymy.]

Tachuda sagittula (Dognin), Draudt, 1932, p. 929. Gaede, 1934, p. 222.

Diagnosis: Size, forewing length, ♂ 12-19 mm, ♀ 22 mm. This is the largest species of the genus. The presence of areas of pale straw yellow scaling on the head, thorax and basal halves of the forewings is characteristic of this species. A prominent black, slightly oblique bar is located between the base of the reniform spot and the base of the inner margin of the forewing in both sexes. The male genitalia are quite similar to those of *D. angulinea*, but the eighth abdominal sternite bears toothed, lateral flanges at the bases of the distal bifurcation, and the aedeagus is slightly less armed with sharp-pointed processes on the apical half of the shaft. The female genitalia are most like those of *D. angulinea* (see Figs. 15 & 18), but *D. tuna* has a broad sclerotized platelike ninth abdominal sternum. The middle of the ninth abdominal sternum of *D. angulinea* is mostly membranous with only some small subtriangular sclerotizations.

Types: The holotype male of *D. tuna* from Colombia and the two syntypes of *Naduna sagittula* Dognin are in the collections of the U.S. National Museum. The syntype of the latter labeled: "*Naduna sagittula* Dgn. Type ♂"; "Dognin Collec-

tion"; "Canon del Tolima, Colomb., Cent. Cord., 1,700 m, Coll. Fassl"; "♂ genitalia on slide 2153, Mar. 1966, ELT." has been selected, labeled and is now designated the lectotype of that nominal species.

Distribution: Only five specimens of this species have been examined. Three are from localities in Colombia, the other two, both males, are from Sixaola River, Costa Rica, and Porto Bello, Panamá.

Food plant: Unknown.

Dunama mexicana Todd, new species

Figs. 3, 6, 13, 17

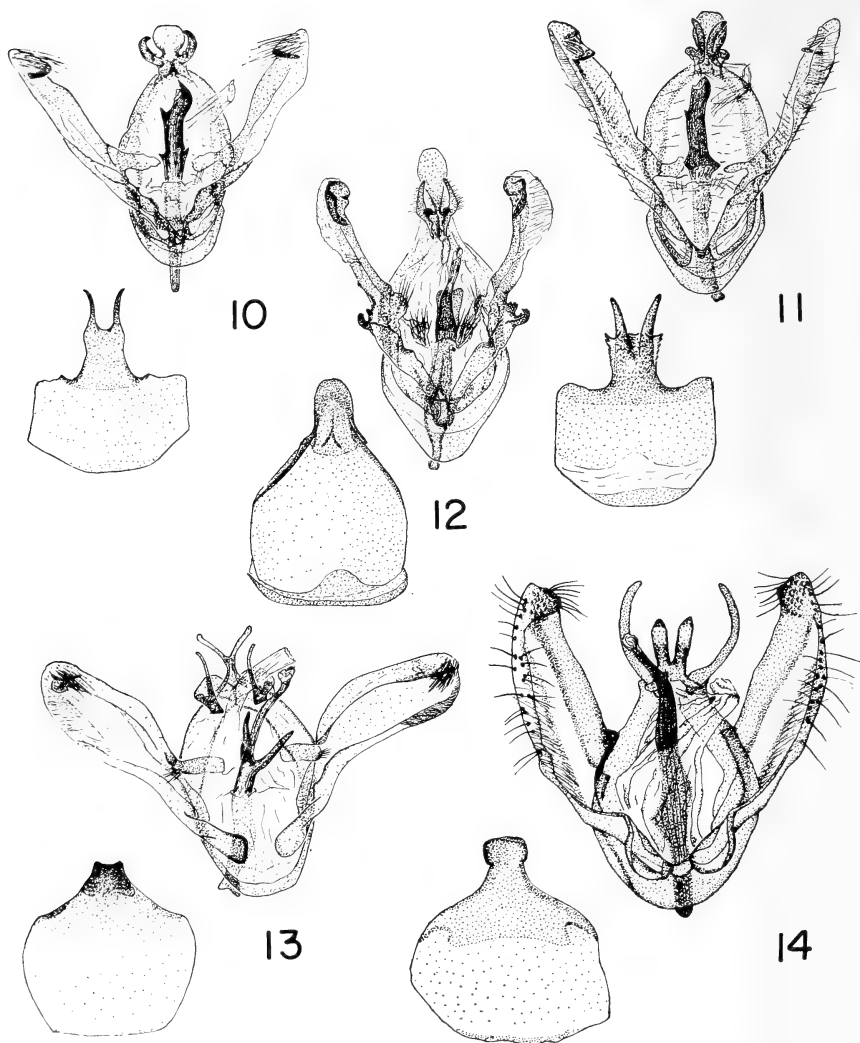
Description: Head with proboscis well developed; labial palpi slightly upcurved to near middle of frons, third segment very small, slightly porrect, second segment about 5 times as long and 2 times as wide, vestiture of short, loose, reddish-brown scales and a few scattered gray scales; frons flat, vestiture loose, scales directed mesoventrad from each side; eyes large, hemispherical, slightly wider than frons in male, subequal to frons in female; antennae of male bipectinate, the pectinations slender, longest at middle of antenna, about 3 times as long as width of article, antennae of female simple. Vestiture of patagia, tegulae and thorax of elongate scales and hairlike setae; patagia with dark brown scales medially, straw yellow scales basally and distally; tegulae nearly uniformly brown; thorax variegated with mixture of reddish-brown and yellowish-brown scales. Abdomen dark brown dorsally, yellowish brown ventrally; dorsal tufts absent. Pectus clothed with long, sparse, yellowish-brown, hairlike setae. Legs of male pale yellowish-brown except trochanter of forelegs dark reddish brown, a dark brown band or apical patch at distal third of tibiae of all legs, and tarsal segments mostly dark brown, each with narrow pale ring at apex. Legs of female usually more uniformly dark brown. Pattern of maculation of dorsal surfaces of wings as illustrated (Figs. 3 & 6); males grayish brown, transverse median band of forewing paler, spots basad of band and in reniform spot dark brown, nearly black; females less maculate and considerably darker brown; ventral surface of wings essentially immaculate in both sexes except some small yellowish-brown, oblique marks on apical half of costal margin of forewing. Length of forewing: male, 11–15 mm, female, 12–17 mm.

Male genitalia distinctive (Fig. 13). Uncus bifid, slender, Y-shaped; aedeagus with two large, spinelike processes from dorsal surface at apical third; ventral margin of valva simple, membranous; posterior margin of eighth abdominal sternite heavily sclerotized and produced medially, upcurved, apex concave. Female genitalia as illustrated (Fig. 17). Posterior margin of ninth abdominal tergum sclerotized and irregularly toothed; ninth abdominal sternite well developed, a deep U-shaped emargination at middle; lateral angles of eighth abdominal sternite flat, sharp-pointed, triangular processes.

Types: Holotype (USNM type no. 64649) male, 6 ♂ and 2 ♀ paratypes, México, reared from "*Chamaedorea elegans*"; 3 ♂ and 2 ♀ paratypes, Tuxapán, V. C., México, reared from "*Chamaedorea elegans*," March 1959, in the U.S. National Museum. One ♂ and 1 ♀ paratype, same data as holotype, in the British Museum (Natural History).

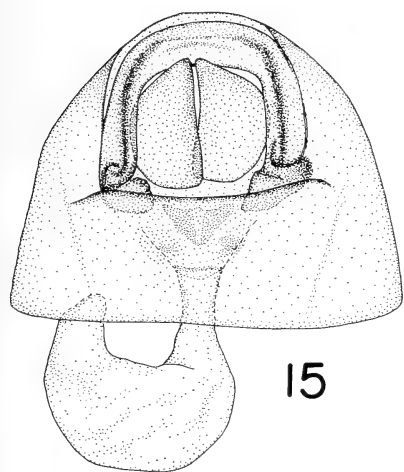
Food plant: Larvae were reared from plants imported by florists as "*Chamaedorea elegans*." There is some question as to the correctness of the identification of the plant, and the original plant material is no longer available for study. Accordingly, the food plant should be listed as *Chamaedorea* sp.

Discussion: The characters given in the key based on maculation and coloration probably will separate most examples from the similar species, *D. angulinea* and *D. claricentrata*, but the genitalia, male or female should be examined for positive identification. There is some question as to the actual area of origin of the plant

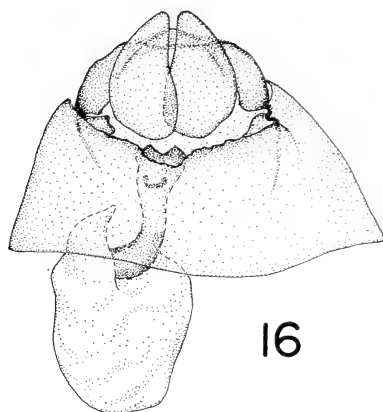


Figs. 10-14. Males, genitalia and ninth abdominal sternites of *Dunama* species: 10, *angulinea*, Quirigua, Guatemala; 11, *tuna*, Porto Bello, Panamá; 12, *claricentrata*, holotype, French Guiana; 13, *mexicana*, paratype, México; 14, *ravistriata*, holotype, French Guiana.

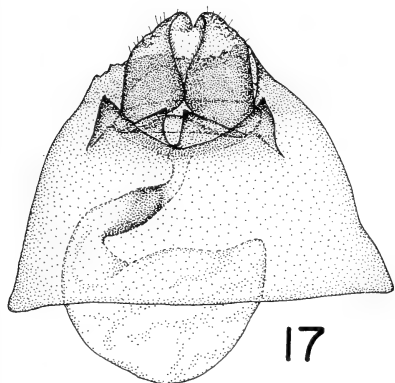
material in México. These plants have rather restricted distributions and the collectors of the plants tend to keep their source secret. After several inquiries in an attempt to determine a type locality, I was informed only that the plants came from northern Veracruz. Later specimens stated to be from Tuxapán, Veracruz were received, but it is not possible to state with certainty that either statement is reliable.



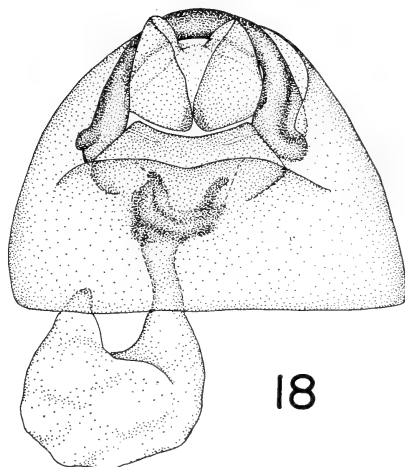
15



16



17



18

Figs. 15–18. Females, genitalia of *Dunama* species: 15, *angulinea*, female, Paraiso, C. Z., Panamá; 16, *ravistriata*, paratype female, Pará, Brazil; 17, *mexicana*, paratype female, México; 18, *tuna*, female, paralectotype of *sagittula*, Río Toche, Colombia.

***Dunama ravistriata* Todd, new species**

Figs. 4, 8, 14, 16

Description: Very much like *D. mexicana* except: vestiture of head and thorax generally darker; frons yellowish-brown; patagia pale at base only; medial band of male forewing conspicuous only at base of cell; a pale longitudinal streak present in both sexes from base of forewing through reniform spot toward termen; legs of male darker than in *D. mexicana*. Length of forewing: male, 14–15 mm, female, 14–17 mm.

Male genitalia distinctive (Fig. 14). Uncus bifid, bifurcations stout, only slightly divergent; socii longer than uncus, stouter than in *D. mexicana*; aedeagus with only

one small, thornlike dorsal process at apical fifth; sclerotized caudal process of eighth abdominal sternite with knob-shaped apex. Female genitalia as illustrated (Fig. 16). Posterior margin of eighth abdominal sternite broadly V-shaped and slightly irregularly toothed.

Types: Holotype male, French Guiana, Bar [collector], ♂ genitalia on slide 2120 E. L. Todd, Jan. 1966 (BMNH Notod. 313); 1 ♂ and 4 ♀ paratypes, same locality and collector; 1 ♂ and 9 ♀ paratypes, Pará, Brazil, A. M. Moss; and 1 ♂ paratype, Teffé, Amaz., Brazil, M. de Mathan, in the British Museum (Natural History). One male and 1 ♀ paratypes, Pará [Brazil], A. M. Moss, and 1 ♀ paratype, Goedeberth, Maroni, French Guiana, Collection Le Moulth, in the U.S. National Museum.

Food plant: Unknown. If a palm, it must be other than the chamaedoreoid group as they do not occur in the area from which the moth is known to occur.

Dunama claricentrata (Dognin), n. comb.

Figs. 5, 12

♀ *Eunotela claricentrata* Dognin, 1916, p. 13.

Diagnosis: Size, ♂, length of forewing 13 mm. Pattern of maculation as illustrated, similar to that of *D. angulinea* and *D. mexicana*. Some differences in maculation have been noted and utilized in the key to species. It must be pointed out that *D. angulinea* and *D. mexicana* are both somewhat variable in maculation and that *D. claricentrata* may easily prove as variable when specimens other than the holotype are available for study. The male genitalia (Fig. 12) are very distinctive and easily permit the identification of the species. The simple action of brushing the hair and scales from the venter of the distal segments of the abdominal sternum and the valves of the genitalia, if slightly produced, would enable one to view the characters of significance. The uncus is spatulate, but more elongated and more membranous medially and distally than that structure in *D. angulinea* and *D. tuna*; the ventral plate of the abdominal sternite is similar to that structure in *D. mexicana* and *D. ravistriata*, not bifurcate as in the other two species; the strongly toothed ventral margin of the valve and the slightly bilobed, flat dorsal process of the aedeagus are not found in any other *Dunama* species.

Type: The holotype male from Nouveau Chantier, French Guiana is in the collection of the U.S. National Museum.

Food plant: Unknown.

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THE BUTTERFLIES OF MISSISSIPPI—SUPPLEMENT NO. 2¹BRYANT MATHER² AND KATHARINE MATHER

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The first list of Mississippi butterflies (Weed, 1894) included 53 species; the second (Hutchins, 1933) included 73; the third (Mather & Mather, 1958) included 122, 45 of which were not included in either of the previous lists. Mather & Mather (1959) removed two names from the 1958 list because the material upon which their inclusion had been based was found to have been incorrectly determined and added two names based on new collecting data. Since 1959 we have prepared and given informal limited circulation to a number of revised manuscript lists, but in each case there have been questions of nomenclature and relationships awaiting resolution through publication by others. It now seems appropriate to issue as a second supplement, a list of the names of the 143 species now known to have been found in Mississippi, arranged in current sequence and designated by current names.

The 120 names included in the 1958 list still regarded as valid are given in their current form and position in the list without further comment. The two added in 1959 were *Nastra neamathla* (Skinner & Williams) (42) and *Satyrium kingi* (Klots & Clench) (86). The 21 additional names, indicated by "*" in the list, are included on the basis of evidence of their occurrence as summarized below. *Wallengrenia egeremet* (Scudder) (31) and *Lethe anthedon* (Clark) (136) were known prior to 1958 to be present in the Mississippi fauna; they are now regarded as species distinct from *Wallengrenia otho* (Smith) (30) and *Lethe portlandia* (Fabricius) (135) respectively, rather than forms of these. The remaining 19 additions represent new data on the Mississippi fauna. Work by Rick Kergosien added six: *Amblyscirtes reversa* Jones (10), *Erynnis funeralis* (Scudder & Burgess) (48), *Urbanus d. dorantes* (Stoll) (59), *Brephidium isophthalma pseudofea* (Morrison) (100), *Anartia jatrophae guantanamo* Munroe (113), and *Hypolimnys misippus* (Linnaeus) (121). Work by Charles T. Bryson added five: *Poanes hobomok* (Harris) (21), *Problema byssus* (Edwards) (25), *Leptotes marina* (Reakirt) (101), *Euphydryas phaeton ozarkae* Masters (127), and *Lethe a. appalachia* Chermock (138). We added four:

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Euphyes dukesi Lindsey (19), *Poanes viator zizaniae* Shapiro (24), *Atrytone d. delaware* (Edwards) (27), and *Calycopis isobea* (Butler & Druce) (89). Work by MacDonald Fulton added *Harkenclenus titus mopsus* (Hübner) (84) and *Eumaeus atala florida* Röber (88). Work by Roy Strickland added *Megathymus y. yuccae* (Boisduval & LeConte) (1), and work by Charles Daniel added *Speyeria c. cybele* (Fabricius) (129).

In the 1958 list there was only one name for which no preserved specimen could then be located: *Phoebis philea* (Johansson) (76); there is still no known Mississippi specimen of this species. Two of the added species fall into this category; their addition being based only on sight records. The basis for their inclusion is as follows:

Eumaeus atala florida (88). Professor MacDonald Fulton, Department of Bacteriology, Mississippi State College for Women, Columbus, Mississippi wrote to me in October 1969 as follows: "In 1966 I saw and observed for at least 10 minutes here on the campus, *Eumaeus atala* (I assume the species—the genus is easy). It was a perfect specimen. No net." Dr. Fulton discussed this observation further with us and with Charles Bryson. There appears to be no doubt as to what he observed.

Hypolimnas misippus (121). In July and August 1970, Rick Kergosien and a number of his colleagues in Bay St. Louis, Hancock Co., Mississippi took a series of specimens of several species of generally more tropical facies than customary for Mississippi. These included: *Anteos maerula lacordairei* (25 July 70) and *Anartia jatrophae guantanamo* (30 July 70 and substantial numbers later). On 6 August 1970 at Bay St. Louis, he and two others observed a female *Hypolimnas misippus*. It lit, was swung at, was missed, and slowly flew away while being chased for 2–3 min. It went over a roof top and was not seen again. All three observers quickly went to Kergosien's residence to examine a female *H. misippus* in his collection. All three were in complete agreement that this was what they saw. The foregoing is summarized from a letter dated 6 August 1970 from Rick Kergosien to us.

Checklist of Mississippi Butterflies

- | | |
|---|--|
| * 1. <i>Megathymus yuccae yuccae</i>
(Boisduval & LeConte) | 7. <i>Amblyscirtes samoset</i> (Scudder) |
| 2. <i>Panoquina panoquin</i> (Scudder) | 8. <i>A. aesculapius</i> (Fabricius) |
| 3. <i>P. ocola</i> (Edwards) | 9. <i>A. carolina</i> (Skinner) |
| 4. <i>Calpododes ethlius</i> (Stoll) | * 10. <i>A. reversa</i> Jones |
| 5. <i>Oligoria maculata</i> (Edwards) | 11. <i>A. vialis</i> (Edwards) |
| 6. <i>Lerodea eufala</i> (Edwards) | 12. <i>A. belli</i> Freeman |
| | 13. <i>A. alternata</i> (Grote & Robinson) |

14. *Atrytonopsis hianna hianna* (Scudder)
15. *A. loammi* (Whitney)
16. *Euphyes arpa* (Boisduval & LeConte)
17. *E. palatka* (Edwards)
18. *E. dion alabamiae* (Lindsey)
- * 19. *E. dukesi* (Lindsey)
20. *E. vestris metacomet* (Harris)
- * 21. *Poanes hobomok* (Harris)
22. *P. zabulon* (Boisduval & LeConte)
23. *P. yehl* (Skinner)
- * 24. *P. viator zizaniae* Shapiro
- * 25. *Problema byssus* (Edwards)
26. *Atrytone arogos* (Boisduval & LeConte)
- * 27. *A. delaware delaware* (Edwards)
28. *Atalopedes campestris* (Boisduval)
29. *Pompeius verna sequoyah* (Freeman)
30. *Wallengrenia otho* (Smith)
- * 31. *W. egeremet* (Scudder)
32. *Polites themistocles* (Latreille)
33. *P. origenes origenes* (Fabricius)
34. *P. vibex vibex* (Geyer)
35. *Hesperia metea* Scudder
36. *H. attalus seminole* (Scudder)
37. *Hylephila phyleus phyleus* (Drury)
38. *Copaeodes minima* (Edwards)
39. *Ancyloxypha numitor* (Fabricius)
40. *Lerema accius* (Smith)
41. *Nastra lherminier* (Latreille)
42. *N. neamathla* (Skinner & Williams)
43. *Pholisora catullus* (Fabricius)
44. *Pyrgus communis communis* (Grote)
45. *P. oileus* (Linnaeus)
46. *Erynnis brizo brizo* (Boisduval & LeConte)
47. *E. zarucco* (Lucas)
- * 48. *E. funeralis* (Scudder & Burgess)
49. *E. martialis* (Scudder)
50. *E. horatius* (Scudder & Burgess)
51. *E. juvenalis juvenalis* (Fabricius)
52. *Staphylus hayhurstii* (Edwards)
53. *Thorybes bathyllus* (Smith)
54. *T. pylades* (Scudder)
55. *T. confusus* Bell
56. *Achalarus lyciades* (Geyer)
57. *Autochton cellus* (Boisduval & LeConte)
58. *Urbanus proteus proteus* (Linnaeus)
- * 59. *U. dorantes dorantes* (Stoll)
60. *Epargyreus clarus clarus* (Cramer)
61. *Battus philenor philenor* (Linnaeus)
62. *P. polyxenes asterius* Stoll
63. *P. cresphontes cresphontes* Cramer
64. *P. glaucus glaucus* Linnaeus
65. *P. troilus troilus* Linnaeus
66. *P. palamedes palamedes* Drury
67. *Graphium marcellus* (Cramer)
68. *Pieris protodice protodice* Boisduval & LeConte
69. *P. rapae* (Linnaeus)
70. *Ascia monuste phileta* (Fabricius)
71. *Colias eurytheme eurytheme* Boisduval
72. *C. philodice philodice* Godart
73. *C. (Zerene) cesonia* (Stoll)
74. *Anteos maerula lacordairei* (Boisduval)
75. *Phoebis sennae eubule* (Linnaeus)
76. *P. philea* (Johansson)
77. *Eurema daira daira* (Godart)
78. *E. mexicana* (Boisduval)
79. *E. lisa lisa* Boisduval & LeConte
80. *E. nicippe* (Cramer)
81. *Nathalis iole* Boisduval
82. *Anthocharis midea midea* (Hübner)
83. *Calephelis virginienensis* Gray
- * 84. *Harkenclenus titus mopsus* (Hübner)
85. *Satyrium liparops strigosa* (Harris)
86. *S. kingi* (Klots & Clench)
87. *S. calanus falacer* (Godart)
- * 88. *Eumaeus atala florida* Röber
- * 89. *Calycopis isobea* (Butler & Druce)
90. *C. cecrops* (Fabricius)
91. *Callophrys henrici turneri* Clench
92. *C. augustinus croesiodes* Scudder
93. *C. niphon niphon* (Hübner)
94. *C. gryneus gryneus* (Hübner)
95. *Atlides halesus halesus* (Cramer)
96. *Euristrymon ontario ontario* (Edwards)
97. *Panthiades m-album m-album* (Boisduval & LeConte)
98. *Strymon melinus melinus* Hübner
99. *Lycaena thoe Guérin-Méneville*
- * 100. *Brephidium isophthalma pseudofea* (Morrison)

- | | |
|--|---|
| *101. <i>Leptotes marina</i> (Reakirt) | *121. <i>Hypolimnys misippus</i> (Linnaeus) |
| 102. <i>Hemiargus ceraunus antibubastus</i>
Hübner | 122. <i>Chlosyne nycteis nycteis</i>
(Doubleday) |
| 103. <i>H. isola alce</i> (Edwards) | 123. <i>C. gorgone gorgone</i> (Hübner) |
| 104. <i>Everes comyntas comyntas</i>
(Godart) | 124. <i>Phyciodes texana seminole</i>
(Skinner) |
| 105. <i>Celastrina argiolus pseudargiolus</i>
(Boisduval & LeConte) | 125. <i>P. tharos tharos</i> (Drury) |
| 106. <i>Feniseca tarquinius tarquinius</i>
(Fabricius) | 126. <i>P. phaon</i> (Edwards) |
| 107. <i>Libytheana bachmanii bachmanii</i>
(Kirtland) | *127. <i>Euphydryas phaeton ozarkae</i>
Masters |
| 108. <i>Anaea andria andria</i> Scudder | 128. <i>Speyeria diana</i> (Cramer) |
| 109. <i>Asterocampa celtis celtis</i>
(Boisduval & LeConte) | *129. <i>S. cybele cybele</i> (Fabricius) |
| 110. <i>A. clyton clyton</i> (Boisduval &
LeConte) | 130. <i>Euptoieta claudia</i> (Cramer) |
| 111. <i>Limenitis arthemis astyanax</i>
(Fabricius) | 131. <i>Heliconius charitonius tuckeri</i>
Comstock & Brown |
| 112. <i>L. archippus watsoni</i> (dos Passos) | 132. <i>Agraulis vanillae nigrrior</i> Michener |
| *113. <i>Anartia jatrophae guantanamo</i>
Munroe | 133. <i>Danaus plexippus plexippus</i>
(Linnaeus) |
| 114. <i>Vanessa atalanta rubria</i>
(Fruhstorfer) | 134. <i>D. gilippus berenice</i> (Cramer) |
| 115. <i>Cynthia virginensis</i> (Drury) | 135. <i>Lethe portlandia missarkae</i>
Heitzman & dos Passos |
| 116. <i>C. cardui</i> (Linnaeus) | *136. <i>L. anthedon</i> (Clark) |
| 117. <i>Precis coenia</i> (Hübner) | 137. <i>L. creola</i> (Skinner) |
| 118. <i>Nymphalis antiopa antiopa</i>
(Linnaeus) | *138. <i>L. appalachia appalachia</i>
Chermock |
| 119. <i>Polygonia interrogationis</i>
(Fabricius) | 139. <i>Cyllopsis gemma gemma</i>
(Hübner) |
| 120. <i>P. comma</i> (Harris) | 140. <i>Euptychia areolata areolata</i>
(Smith) |
| | 141. <i>E. hermes sosybia</i> (Fabricius) |
| | 142. <i>E. cymela cymela</i> (Cramer) |
| | 143. <i>Cercyonis pegala abbotti</i> Brown |

Note added in proof: Species No. 144, *Erynnis baptisiae* (Forbes), was added to the list of those known from Mississippi as a result of one male having been taken on 19 March 1976 by Mike Rickard at the Big Biloxi Recreation Area, Harrison Co., on blackberry blossoms along the railroad track. The determination was confirmed by Dr. John M. Burns who previously (1964) regarded it as "rather surprising" that it had not then yet been found in Mississippi.

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RHOPALOCERA IN THE N. B. SANSON COLLECTION

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Norman Bethune Sanson served as Curator at the Banff National Park, Alberta, Museum from 1896–1931, during which time he gathered together much insect, plant, and other material. This collection includes 585 labelled Alberta specimens of skippers and butterflies, representing 71 different taxa. These collections are reported here, along with some biographical notes on Sanson, as little has been published on either the Rhopalocera of the Park (Bean, 1890–1893) or on Sanson himself.

N. B. Sanson was born on 1 November 1861, in Toronto, Ontario. He came west in 1885 as a member of the Queen's Own Regiment and participated in the fierce battles against the forces of Louis Riel at North Battleford and Prince Albert, Saskatchewan. In 1892 he travelled to Banff and became an accountant at the Sanatorium Hotel and at a general store. In 1896 he was hired by the Canadian Government and appointed as a Meteorological Officer and as Curator of the Museum. His work in the first position involved the keeping of detailed weather records, especially in an observatory erected in 1902–1903 on the top of Sulphur Mountain at an elevation of 8,030 ft., some 3,500 ft. above the town of Banff. It has been estimated that he climbed to this observatory some 815 times, usually every two weeks, to man the weather instruments. Many of his collections were made on these hikes. His work as Curator involved the gathering of extensive collections and data on the local fauna and flora. The earliest Rhopalocera collection made by him is dated 10 May 1897, the latest 12 June 1929, but most collections were made in the period from 1906–1912. His collection includes a small number of specimens collected by J. Macoun, T. E. Bean, and J. Fletcher, and it is assumed that he was personally acquainted with these individuals. He was also acquainted with F. H. Wolley Dod as some of his collections are cited for Banff in the first list of the species of the province which Wolley Dod published in 1901. Wolley Dod and Arthur Gibson helped identify his material according to some determination labels. Sanson died at the age of 88 on 30 May 1949 and was buried in the Banff Cemetery.

Annotated List

The following list includes all of the Alberta specimens, mostly from Banff National Park, in the N. B. Sanson collection. The geographical

location of the collections is indicated along with the flight period. The scientific names employed, unless otherwise indicated, are those of the latest list of North American taxa by dos Passos (1964) and of subsequent revisions to it by the same author (1969, 1970). The identifications of all of the specimens have been either verified or revised by the author.

HESPERIIDAE

Polites coras (Cramer)—Coras Skipper. Banff. July 27–31.

Hesperia manitoba (Scudder)—Manitoba Skipper. Banff, Mystic Lake, Sulphur Mountain, Tunnel Mountain. June 18–August 24. The name of this taxon, listed as *H. comma manitoba* by dos Passos (1964), was altered to the above by MacNeill (1964).

Carterocephalos palaemon mandan (Edwards)—Arctic Skipper. Banff, Mt. Rundle, Spray River Valley, Sulphur Mountain, Tunnel Mountain. June 5–July 27.

Pyrgus centaurae loki Evans—Grizzled Skipper. Banff. June 12.

Pyrgus ruralis (Boisduval)—Ruralis Checkered Skipper. Banff, trail to Lake Minnewanka, Simpson Pass, trail to Stony Squaw Mountain, Tunnel Mountain. May 8–July 13.

Erynnis icelus (Scudder & Burgess)—Dreamy Dusky Wing. Banff. June 25.

Erynnis persius fredericki H. A. Freeman—Persius Dusky Wing. Banff, Sulphur Mountain, Upper Anthracite Road. May 4–July 14.

PAPILIONIDAE

Parnassius phoebus smintheus Doubleday—Parnassian. Aylmer Pass, Cascade Mountain, Simpson Pass, Stony Squaw Mountain, Sulphur mountain. August 6–October (day not mentioned).

Papilio glaucus canadensis Rothschild & Jordan—Tiger Swallowtail. Banff. May 23–July 5.

PIERIDAE

Neophasia menapia menapia (Felder & Felder)—Pine White. Sulphur Mountain. August 10–September 6.

Pieris sisymbrii flavitincta J. A. Comstock—California White. Tunnel Mountain. June 7.

Pieris protodice occidentalis Reakirt—Western Checkered White. Banff, Sulphur Mountain. April 25–September 20. Considered a separate species, *P. occidentalis*, by some recent workers.

Pieris napi oleracea Harris—Mustard White. Sundance Canyon Road, Tunnel Mountain, Upper Anthracite Road. May 23–August 8.

Colias meadii elis Strecker—Elis Sulphur. Banff, Cascade Mountain, Ptarmigan Valley, Sulphur Mountain. July 21–September 4.

Colias philodice eriphyle Edwards—Alfalfa Butterfly. Banff; F. H. Wolley Dod's Ranch, SW of Calgary. June (day not mentioned)—October 4. Ultraviolet photographic studies by Ferris (1972) and others have shown *C. philodice* and *C. eurytheme* to be different species. The taxon *eriphyle* belongs to the *philodice* complex.

Colias interior interior Scudder—Pink-edged Sulphur. Ptarmigan Valley. June 21.

Colias alexandra christina Edwards—Christina Sulphur. Banff, Lake Minnewanka, Sulphur Mountain, Sundance Canyon Road. July 18–August 20. Four (57%) of seven females were albinistic. The subspecific nature of this species in Alberta has been discussed by Ferris (1973).

Colias pelidne minisni Bean–Pelidne Sulphur. Sundance Canyon Road. July 18.
Colias nastes streckeri Grum–Grschimailo–Nastes Sulphur. Cascade Mountain.
 August 25.

Euchloe creusa (Doubleday)–Creusa Marble. Banff, 40 Mile Creek Campground, Sulphur Mountain, Tunnel Mountain, Upper Anthracite Road. May 21–September 25.

Euchloe ausonides ausonides Lucas–Marbled White. Banff. May 17–July 1.

LYCAENIDAE

Callophrys polios obscurus Ferris and Fisher–Hoary Elfin. Upper Anthracite Road. May 28–June 9. This subspecies was recently described by Ferris & Fisher (1973).

Callophrys augustinus iroides (Boisduval)–Brown Elfin. Banff, Sundance Canyon Road, Upper Anthracite Road. May 5–June 9. The relationship of this subspecies and of ssp. *augustinus* (Westwood) in Alberta are discussed in dos Passos (1943).

Callophrys eryphon eryphon (Boisduval)–Western Pine Elfin. Banff, Spray River Valley. April 24–June 24.

Lycaena mariposa mariposa Reakirt–Mariposa Copper. Banff, trail to Lake Minnewanka, Mystic Lake, Stony Squaw Mountain. July 25–September 25.

Lycaena dorcas dorcas Kirby–Dorcas Copper. Banff. July 19–25.

Lycaena phlaeas arethusa (Wolley Dod)–Arethusa Copper. Vermilion Range. Date not mentioned.

Lycaena snowi (Edwards)–Snow's Copper. Upper Kananaskis Pass, Vermilion Range. August 3. Alberta material may belong to ssp. *henryae* (Cadbury) described from Caribou Pass, B.C.

Lycaeides argyrognomon scudderii (Edwards)–Scudder's Blue. Banff, Lake Minnewanka, Stoney Creek to Cascade Valley, Sulphur Mountain, Sundance Canyon. July 10–August 11.

Plebejus saepiolus amica (Edwards)–Saepiolus Blue. Banff, Laggan (J. Fletcher), Tunnel Mountain. June 19–August 3.

Plebejus acmon lutzii dos Passos–Acmon Blue. Banff. August 7. Goodpasture (1973) has shown that *lutzii* is the only subspecies of *Plebejus acmon* in Alberta.

Plebejus aquilo megalo McDunnough–Mountain Arctic Blue. Banff, Ptarmigan Valley, Simpson Pass, Sulphur Mountain. June 21–September 1.

Plebejus aquilo rustica (Edwards)–Plains Arctic Blue. F. H. Wolley Dod's Ranch, SW of Calgary. June 19.

Everes amyntula albrighti Clench–Western Tailed Blue. Banff, Sulphur Mountain, Tunnel Mountain, Upper Anthracite Road, Whiteman's Cabin. June 9–August 2.

Glaucopteryx lydamus couperi Grote–Silvery Blue. Banff, Sulphur Mountain, Tunnel Mountain, Whiteman's Cabin. June 11–July 29.

Celastrina argiolus lucia (Kirby)–Spring Azure. Banff, base of Stony Squaw Mountain. May 21–June 24.

NYMPHALIDAE

Limenitis arthemis rubrofasciata (Barnes & McDunnough)–White Admiral. Anthracite, Banff. July 12–30.

Vanessa atalanta rubria (Fruhstorfer)–Red Admiral. Stony Squaw Mountain, Sulphur Mountain. June 24–26.

Cynthia cardui (Linnaeus)–Painted Lady. Banff, Stony Squaw Mountain. June 26–July 1. Specimens of this occasional migrant to Alberta were collected only in 1911 and 1914.

Nymphalis vaughani j-album (Boisduval & Le Conte)–Compton's Tortoise-shell. Banff. August 18–September 30.

Nymphalis californica californica (Boisduval)—California Tortoise-shell. Banff, Sulphur Mountain. One specimen of this occasional migrant was collected on June 10, 1912, while 11 were taken on September 12, 1911.

Nymphalis milberti (Godart)—Milbert's Tortoise-shell. Banff, Cascade Mountain, Sulphur Mountain. July 30–August 29.

Nymphalis antiopa antiopa (Linnaeus)—Mourning Cloak. Banff. August 24–September 26.

Polygonia satyrus satyrus (Edwards)—Satyr Angle-wing. Banff, base of Stony Squaw Mountain. May 12–27.

Polygonia faunus rusticus (Edwards)—Green Comma. Banff, Sulphur Mountain. April 23–30, September 2–23.

Polygonia zephyrus (Edwards)—Zephyrus Angle-wing. Banff, Sulphur Mountain. May 7, August 9–September 16.

Phyciodes tharos pulchella (Boisduval)—Pearl Crescent. Banff. July 15–31.

Phyciodes campestris camillus Edwards—Meadow Crescent. Banff, Lake Minnewanka, Sundance Canyon Road. June 17–August 6.

Euphydryas anicia anicia (Doubleday)—Anicia Checkerspot. Banff, Lake Minnewanka, Ptarmigan Valley, Stony Squaw Mountain, Sulphur Mountain. May 29–July 30. The type locality for *anicia* is Banff, Alberta.

Boloria selene atrocotalis (Huard)—Silver-bordered Fritillary. Banff. June 17.

Boloria toddi jenistai Stallings & Turner—Meadow Fritillary. Calgary. June 8.

Boloria frigga saga (Staudinger)—Frigga Fritillary. Banff, Spray River Valley. May 21–June 30.

Boloria freija freija (Thunberg)—Freija Fritillary. Banff, Rundle Mountain trail. April 28–June 12.

Boloria astarte astarte (Doubleday)—Astarte Fritillary. Sulphur Mountain. July 20.

Boloria titania grandis (Barnes & McDunnough)—Purple Lesser Fritillary. Banff, Simpson Pass, trail to Stony Squaw Mountain, Sulphur Mountain. June 24–August 22.

Boloria eunomia dawsoni (Barnes & McDunnough)—Bog Fritillary. Banff, Cascade Mountain, Ptarmigan Valley, Simpson Pass. June 3–August 26.

Speyeria atlantis beani (Barnes & Benjamin)—Bean's Fritillary. Banff, Sulphur Mountain. June 25–August 27.

Speyeria atlantis helena dos Passos & Grey—Northwestern Silverspot. Banff, Sulphur Mountain. July 27–August 2. The distinction between the two subspecies of *atlantis* is often tenuous. The three specimens labelled ssp. *helena* were lighter underneath than those called ssp. *beani*.

Speyeria hydaspe sakuntala (Skinner)—Hydaspe Fritillary. Banff, Sulphur Mountain. July 23–August 22.

Speyeria mormonia eurynome (Edwards)—Mormon Fritillary. Banff, Upper Kananaskis Pass. July 11–August 18.

SATYRIDAE

Coenonympha tullia inornata Edwards—Ringlet. Banff. June 24. Though referred to as *C. inornata* in dos Passos (1964), Brown (1955) has shown that *inornata* should be included within *C. tullia*.

Cercyonis oetus charon (Edwards)—Small Meadow Brown. Banff. July 18–August 8. Emmel (1969) refers Alberta material to the ssp. *charon* and regards it as distinct from ssp. *oetus*. The two were regarded as synonymous by dos Passos (1964).

Oeneis uhleri varuna (Edwards)—Varuna Arctic. Kananaskis (J. Macoun, no date); F. H. Wolley Dod's Ranch, SW of Calgary. June (no day mentioned).

Oeneis chryxus (Doubleday)—Chryxus Arctic. Banff, Lake Minnewanka, Ptarmigan Valley, Spray River Valley, Sulphur Mountain, Tunnel Mountain. May 23–

July 25. Banff area material is close to ssp. *caryi* described from Smith Landing in extreme northeastern Alberta.

Oeneis jutta chermocki Wyatt–Jutta Arctic. Banff, Lake Louise (J. Fletcher), Ptarmigan Valley, Spray River Valley. June 7–August 2. This subspecies was described by Wyatt (1965) after the appearance of dos Passos' (1964) Synonymic List. Masters (1969) regards it as "a weak but valid subspecies somewhat intermediate between *Oeneis jutta ridingiana* . . . and *Oeneis jutta reducta*."

Oeneis melissa beanii Elwes–Bean's Arctic. Sulphur Mountain. June 28–July 29. *Oeneis polixenes brucei* (Edwards)–Bruce's Arctic. Ptarmigan Valley, Sulphur Mountain. July 23–29.

Erebia disa mancinus Doubleday–Mancinus Alpine. Banff, Spray River Valley, Sulphur Mountain. June 18–July 12.

Erebia discoidalis macdunnoughi dos Passos–Red-disked Alpine. Banff, May 2–June 20.

Erebia epipsodea epipsodea Butler–Mountain Common Alpine. Banff, Ptarmigan Valley, Sulphur Mountain. June 5–August 11.

Erebia epipsodea freemani Ehrlich–Plains Common Alpine. F. H. Wolley Dod's Ranch, SW of Calgary, June (day not mentioned). Dos Passos (1964) regarded this taxon as ssp. *sineocellata* but as it was described on the basis of aberrant material (Ehrlich, 1955) "without ocelli," *sineocellata* should be regarded as a "form" name only.

ACKNOWLEDGMENT

Biographical information was graciously provided by Miss Aileen Harmon.

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EVIDENCE OF BREEDING MIGRANT POPULATIONS OF *LEPTOTES CASSIUS* (LYCAENIDAE) IN KANSAS

Three newly emergent specimens of *Leptotes cassius* Cramer were captured during a field study conducted on 15 June 1975 within the city limits of Lawrence, Kansas. The range of this species is normally southern Florida and southern Texas, and these records represent a rarity in northeastern Kansas (Lawrence is situated in Douglas Co., ca. 35 miles west of Kansas City).

All three specimens were female; two were released with the intention of propagating the species locally, and one was mounted in lamination for a permanent record. Other records of *L. cassius* occurring in Kansas are as follows: (1) 24 July 1935, Douglas Co., one specimen; (2) 4 July 1935, Scott Co., one specimen (Field 1938, Studies in Kansas Insects, p. 163-164).

The presence of three females might indicate a local breeding (migrant) population, although Dr. J. C. Downey (pers. comm.) suggests: (1) pupae of *L. cassius* may have been imported with *Plumbago* transplants from Florida and (2) the lack of northern populations even in northern Florida indicates that one must be cautious when concluding that an indigenous population exists in northeastern Kansas. A search of the capture area failed to yield any *Plumbago*, neither in adjacent lots nor in any greenhouse in Lawrence. However, *Phaseolus* is common throughout the neighborhood and is listed as an alternate larval food plant (Klots 1951, A Field Guide to the Butterflies, p. 157-158).

It is extremely unlikely that these three female specimens of *L. cassius* represent windblown migrants at such an early date in Kansas. Subsequent field collection data in this area are necessary and will be continued over the next two years to establish the probable migrant breeding residency of this butterfly.

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NOTES ON THE BIOLOGY AND IMMATURE STAGES OF THE
WHITE PEACOCK BUTTERFLY, *ANARTIA JATROPHAE*
GUANTANAMO (NYMPHALIDAE)

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Observations on the white peacock butterfly, *Anartia jatrophae guantanamo* Munroe, are recorded here to fill gaps in the documentation of this species' life history. A small colony near New Smyrna Beach, Florida was studied in June 1970.

Anartia jatrophae guantanamo was described from Guantanamo, Cuba (Munroe, 1942). Distributed locally in Florida, it is sometimes common in the east and west coastal areas. It has been reported as far north as Tampa on the west coast, and on the east coast it occurs in decreasing numbers not much farther north than Daytona. Strays have been taken by collectors as far north as Savannah, Georgia and southern New England. The range in the United States extends as far south as the Everglades and Keys.

Local distribution of the butterfly in Florida is confined to low ground along shallow ditches and the borders of ponds and streams where its larval food plant, *Bacopa Monniera* (L.) Wettst. (Scrophulariaceae) grows. Because the food plant, commonly called hedge or water hysop, depends on adequate moisture for survival, relative scarcity of the butterfly during drought may result from adverse effects of dry weather on the plant as well as on the butterfly itself. Usually a gravid female oviposits a single ovum on the ventral surface of a water hysop leaf and flies to a plant some distance away to deposit another single ovum. This scattered distribution of eggs may provide a higher rate of survival.

Descriptions

Ovum (Figs. 1A, B). Color pale pearly yellow, turns darker usually on second or third day. Shape similar to squat barrel; ten (\pm) evenly spaced longitudinal keeled ribs arise from flattened base and expand upward in conformity to wider portion of ovum, then narrow toward top where each rib ends abruptly at boundary of flattened micropile.

Dimensions: Height 0.60 mm, width 0.50 mm.

First instar (Figs. 1C, D). On emerging from ovum, larva has large black head capsule, about one-third larger than first thoracic segment; disproportion becomes less evident as larva grows.

Color of body pale greenish-yellow, at first; after completely consuming its egg shell and feeding on succulent green leaves of water hysop, color changes to darker green, then brown just prior to ecdysis.

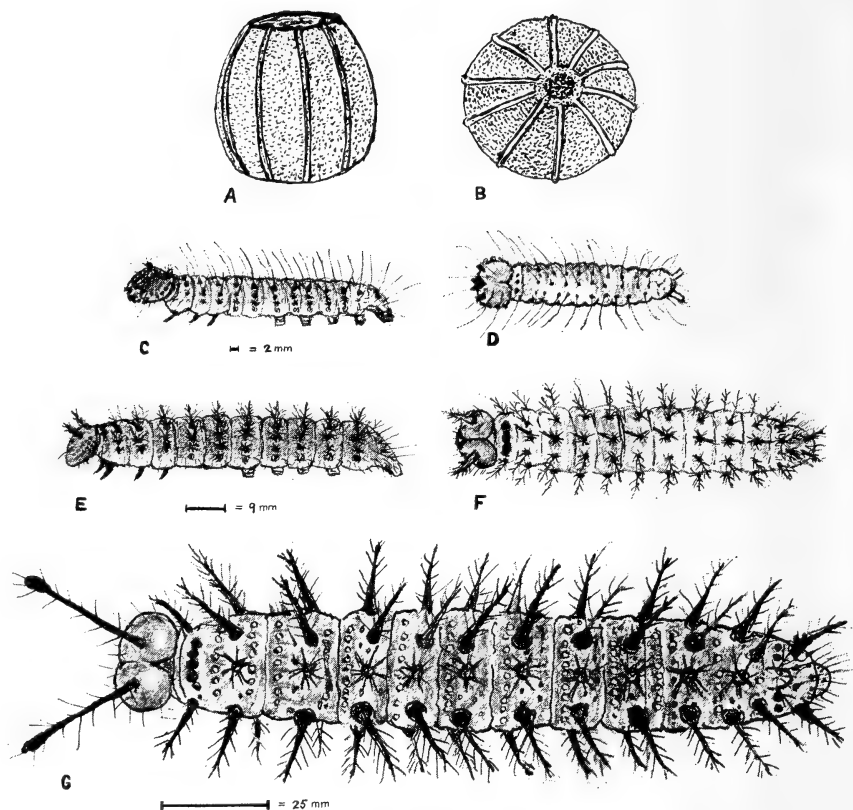


Fig. 1. *Anartia jatrophae guantanamo* Munroe. (A) ovum, lateral view; (B) ovum, dorsal view; (C) larva, first instar, lateral view; (D) larva, first instar, dorsal view; (E) larva, second instar, lateral view; (F) larva, second instar, dorsal view; (G) larva, third instar, dorsal view.

Throughout first instar, shiny black head contrasts with lighter body; entire larva covered by fine blackish hair-like spines arising from dark pyramid-like bases; spines bend over the back in a gentle curve toward the head.

Dimensions: Length of newly-emerged larva, 1.5 mm (\pm); full-grown, 3.0 mm (\pm).

Duration of first stadium: 4 days (\pm).

Second instar (Figs. 1E, F). Head, mandibles, and forelegs shiny black; head somewhat rounded, its two branched spines appreciably longer and thicker than in first instar, as are branched spines on body. Cervical shield on first thoracic segment has chain of four, dark, wartlike nodules. Anal segment bears two dorsolateral branched spines surrounded by short hair-like bristles.

Dimensions: Length of newly emerged larva, 3.0 mm (\pm); full-grown, 8–10 mm.

Duration of second stadium: 4 days.

Third instar (Figs. 1G, 2A, B, C). It is difficult to determine the change from second to third instar unless, in ecdysis, the cast skin is noticed. Careful observation is needed here because the skin soon is consumed by the larva after ecdysis.

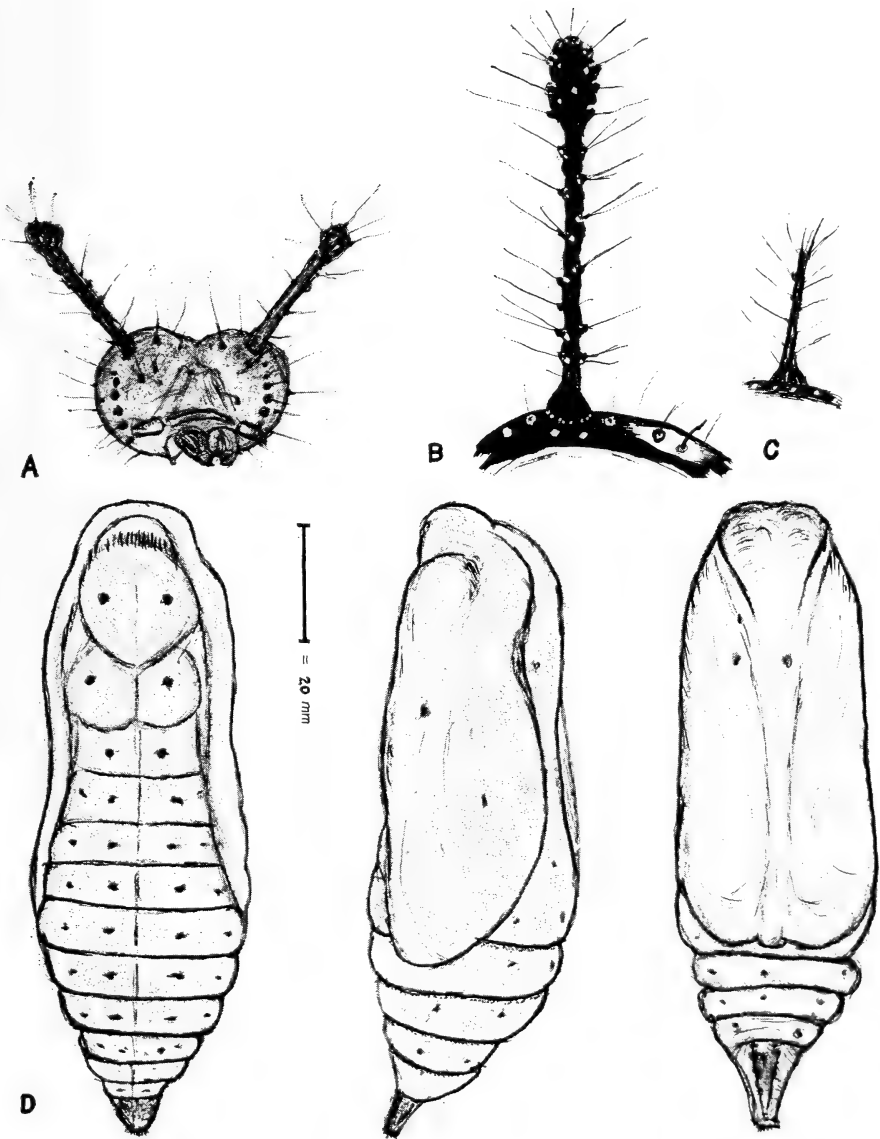


Fig. 2. *Anartia jatrophae guantanamo* Munroe. (A) larva, third instar, facial mask; (B) larva, third instar, one of dorsal branched spines on head; (C) larva, third instar, one of branched spines on body; (D) pupa, from left to right, dorsal, lateral, ventral views.

Immediately after ecdysis, head, branched spines, legs, and prolegs conspicuous dull yellow; within 30 (\pm) minutes, the same structures turn dark brown to black.

Basic body color dark brown to black, but ventral surface lighter dull yellowish-brown; chain of very small silver spots runs closely parallel to anterior and posterior margins of each body segment on dorsal and ventral surfaces; papillae or bases of spines and prolegs dull orange. Anal segment equipped with curved hooklets. From mesothorax to next-to-last abdominal segment, five parallel rows of spines run lengthwise along body; median dorsal row is flanked left and right by two dorso-lateral rows of somewhat larger spines. From head, prothorax, and anal segment arises a pair of dorsolateral spines, the cephalic ones terminating in clubs.

Dimensions: Length of newly emerged larva, 10.0–12.0 mm; full-grown, 27.0–30.0 mm. Length of full-grown third instar larvae indicates sex, as larger individuals develop into female imagoes.

Duration of third stadium: 4–5 days.

Pupa (Fig. 2D). Surface smooth, unornamented, light green but darkens in color nearing time of eclosion; dorsal surface has 2–4 light spots on each segment divided by black central line extending from head to tail; scattered white spots on wing pads and on ventral surface. Posterior end of body terminates in dark brown cremaster.

Dimensions: average length, 17.5–20.0 mm.

Duration of pupal stadium: 7–10 days.

Pupa hangs head down suspended by cremaster embedded in pad of silk attached to some support. Eclosion of imago takes place in about 15 min., and 20 min. or more pass before its wings can sustain flight.

ACKNOWLEDGMENTS

I wish to express my thanks and appreciation for assistance rendered to me by Drs. H. A. Denmark and Howard V. Weems, Jr., Florida Department of Agriculture, Gainesville; and also, to Dr. Lee D. Miller, Allyn Museum for preparing photographs of *Anartia j. guantanamo* genitalia. I am particularly grateful to my colleague Mr. Marc Roth, Entomology Department, National Museum of Natural History for his assistance in correcting and improving my manuscript.

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A NEW SPECIES OF THE GENUS *Bertelia* B. & McD. (PYRALIDAE)

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An examination of specimens of *Bertelia grisella* B. & McD. in the National Museum, including the cotype, shows that I had misidentified my series of specimens of the same genus, taken in the Presidio and Culberson cos. of Texas, recorded in my 1970 article. These specimens really belong to a new species, the description of which follows.

***Bertelia dupla* A. Blanchard, new species**

The description of the habitus of *Bertelia grisella*, as published by Barnes & McDunnough (1913) and Heinrich (1956) applies extremely well to the new species. The specimens of *B. grisella* in the National Collection (*ex* Barnes Collection) are somewhat paler but this is probably due, at least in part, to fading. The maculation of the new species is shown in Figures 1 and 2.

Male genitalia (Figs. 3–6): Uncus triangulate. Valves simple. Vinculum broadly rounded. Apical process of gnathos developed as a long, tapered hook narrowly and deeply notched at apex. Transtilla with strong sclerotization limited to two long processes embracing the aedeagus by their bases, extending dorsad of the aedeagus beyond the base of the gnathos hook, weakly united a trifle distad of their middle, where they are narrowest, by a short, narrow bridge, enlarged and flattened basad of this bridge, enlarged and tricuspid at their apices. Juxta U-shaped with long flattened lateral arms, widest near their middles, pointed at their apices. Aedeagus with a row of minute spines on each of two lateral, symmetrical edges. Penis with a few sclerotized wrinklins, otherwise unarmed. Eighth abdominal segment with a pair of ventrolateral hair tufts.

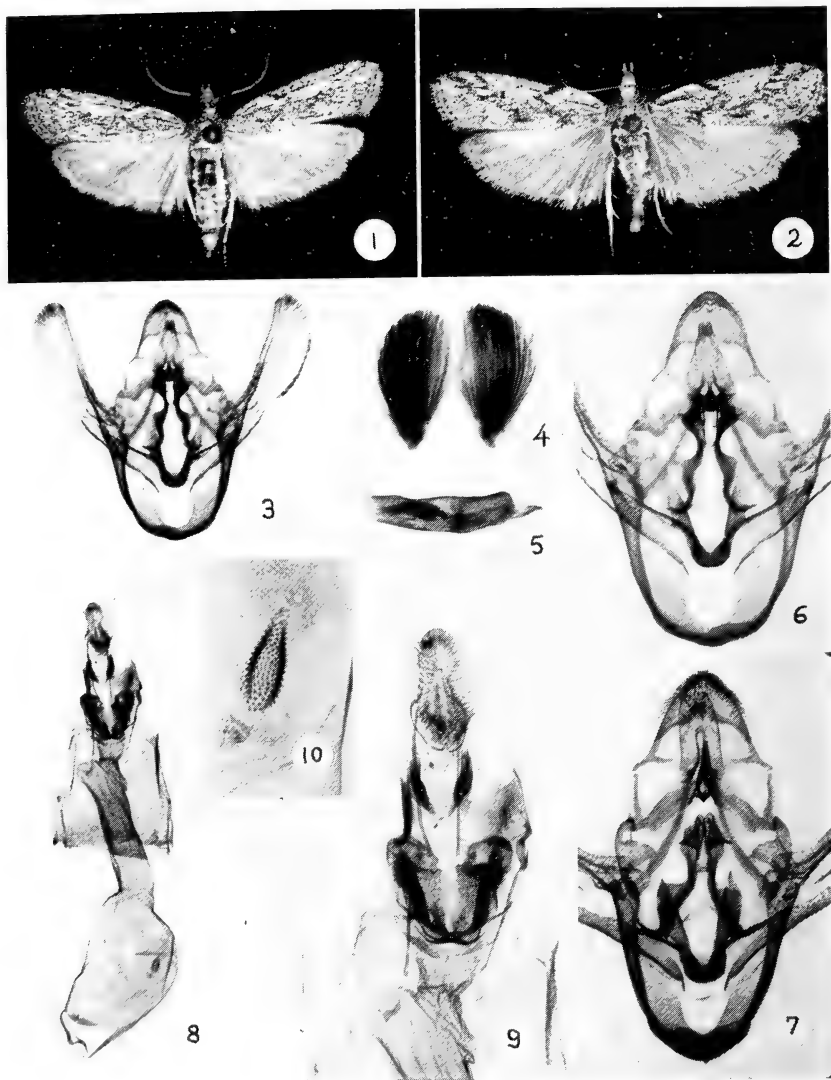
Female genitalia (Figs. 8–10): Similar to those of *Bertelia grisella*.

Wing expanse: 23–27 mm, average 25.5 mm.

Holotype: Male, Shafter, Presidio Co., Texas, 19 Oct. 1973, deposited in the National Museum of Natural History (No. 73530).

Paratypes: Shafter, Texas, 18 Oct. 1968, 3 ♂, 2 ♀; 15 Oct. 1969, 8 ♂, 28 ♀; 16 Oct. 1973, 1 ♂, 4 ♀; 19 Oct. 1973, 1 ♀; Guadalupe Mts. Nat. Park, Bear Canyon, 2 Oct. 1969, 1 ♂, 3 ♀. All types collected by A. & M. E. Blanchard.

B. grisella is the only other species in the genus *Bertelia*. It is to be expected that, when fresh, unfaded specimens of *B. grisella* are available, it will be necessary to dissect the males to distinguish them from *B. dupla*. The transtilla of *B. grisella*, shown in Figure 7, is abundantly different: the laterodorsal processes are much shorter and do not reach the base of the gnathos hook, and the shape of the enlarged apices differs considerably.



Figs. 1-2. *Bertelia dupla*: 1, male holotype; 2, female paratype.

Figs. 3-6. *Bertelia dupla* male genitalia, slide A. B. 3595: 3, genitalia, aedeagus omitted; 4, tufts of eighth abdominal segment; 5, aedeagus; 6, enlarged genitalia showing transtilla.

Fig. 7. *Bertelia grisella*, cotype male genitalia, aedeagus omitted, enlarged to show transtilla, slide USNM 52494 by A. B.

Figs. 8-10. *Bertelia dupla*, female genitalia, slide A. B. 3594: 8, genitalia including seventh abdominal segment; 9, enlarged posterior part; 10, signum of bursa.

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My thanks are due to Mr. Roger Reisch, ranger in the Guadalupe Mts. National Park for helping me to set my traps in the hard to reach Bear Canyon, to Mr. Philip F. Van Cleave for permission to collect there, to the National Museum for the loan of seven specimens and to Dr. Douglas C. Ferguson for arranging the loan.

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A POPULATION OF THE STRIPED HAIRSTREAK, *SATYRIUM LIPAROPS*
LIPAROPS (LYCAENIDAE), IN WEST-CENTRAL FLORIDA

As a resident species, *Satyrium liparops liparops* Boisduval & LeConte, has been previously reported only from the north Florida border and panhandle areas (Kimball 1965, Vol. I, Div. Plant Industry, Gainesville, 363 p.). However, on 15 May 1973, a freshly emerged female *S. l. liparops* was captured at Chassahowitzka, Citrus Co., Florida along the border of a hydric forest at the headwaters of the Chassahowitzka River. Two other adults were observed but not collected in the same location on that date. They were present in an ecotone area of young and mature hammock trees dominated by basswood (*Tilia floridana*), southern magnolia (*Magnolia grandiflora*), water ash (*Fraxinus caroliniana*), sweet bay (*Magnolia virginiana*), water oak (*Quercus nigra*) and bald cypress (*Taxodium distichum*).

The area was revisited in early June 1975, and two more *S. l. liparops* were collected and several others observed. These specimens were more worn than the female collected in May 1973. All adults observed or collected at this Florida west-coast locality are typical *S. l. liparops* having the conspicuous orange-brown patches on the upper sides of the wing rather than the subspecies, *S. l. strigosa*, which occurs over wide areas of Georgia.

A careful examination of vegetation in the Chassahowitzka area produced two early instar larvae of *S. liparops* (identified by rearing) in mid-June 1975. They were found on tree blueberry (*Vaccinium* sp.) in the same area where the adult hairstreaks were previously encountered. In Georgia (Harris 1972, Univ. Okla. Press, Norman, 326 p.), *S. liparops* produces only one brood annually with adults flying from May-July. This is compatible with my Florida data.

The presence of a population of *S. liparops* halfway down the west coast of peninsular Florida suggests that the striped hairstreak may be present over a much wider area of the southern Gulf and Atlantic Coastal Plains than previously reported.

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THE STATUS OF *SATYRIUM BOREALE* (LYCAENIDAE)

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The hairstreak butterfly *Satyrrium boreale* (Lafontaine) was described by its author as phenotypically similar to *Satyrrium falacer* (Godart). In samples from the Peabody Museum and the collections of D. F. Schweitzer and the author, intergradations appear between the wing patterns of these two species. This observation, along with the noted plasticity in wing pattern of *S. falacer* and the related *Satyrrium caryaevorum* (McDunnough), prompted a detailed investigation of the status of *S. boreale*. I propose that the characters of *S. boreale* fall within the pattern of variation of *S. falacer*.

EXPERIMENTAL PROCEDURES

I have chosen to designate phenotypic characters consistent with those described for *S. boreale* by Lafontaine as "type B" and those described for *S. falacer* as "type F." From ca. 120 available male *Satyrrium*, a colleague selected a random sample of 96 specimens, unsorted with respect to their phenotypic characteristics. He then removed the abdomens, placing them individually into glass vials, with the specimens and abdomens cross-referenced by number. I then attempted a genitalic determination for each abdomen, without knowing from which specimen it came. Next, I sorted the pinned specimens by type B and type F wing pattern without reference to the genitalic determinations. In both methods of determination, the characters distinguishing *S. boreale* from *S. falacer* (Lafontaine, 1970) were followed closely. The *Satyrrium* examined were from the Peabody Museum and the author's collection. Of the 96 *Satyrrium*, 2 were genitally determined as *caryaevorum* and set aside. Locality data for the sample specimens are as follows: Connecticut, 69; Virginia, 6; New York, 3; Massachusetts, 3; Wisconsin, 2; Illinois, 2; Kansas, Pennsylvania, Colorado, and Missouri, each 1 specimen. Five other specimens had no data labels.

RESULTS AND DISCUSSION

In the *S. falacer-boreale* series, 65 specimens were identified by wing pattern as type F and 29 as type B. From genitalic determinations, 43 were identified as type F and 51 as type B.

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TABLE 1. Test of correlation between wing pattern and saccus characters in male *Satyrium*.*

Saccus	Type B Wing Pattern (n = 29)		Type F Wing Pattern (n = 65)	
	Expected if uncorrelated	Observed	Expected if uncorrelated	Observed
Type B (n = 51)	15.7	17	35.3	34
Type F (n = 43)	13.3	12	29.7	31

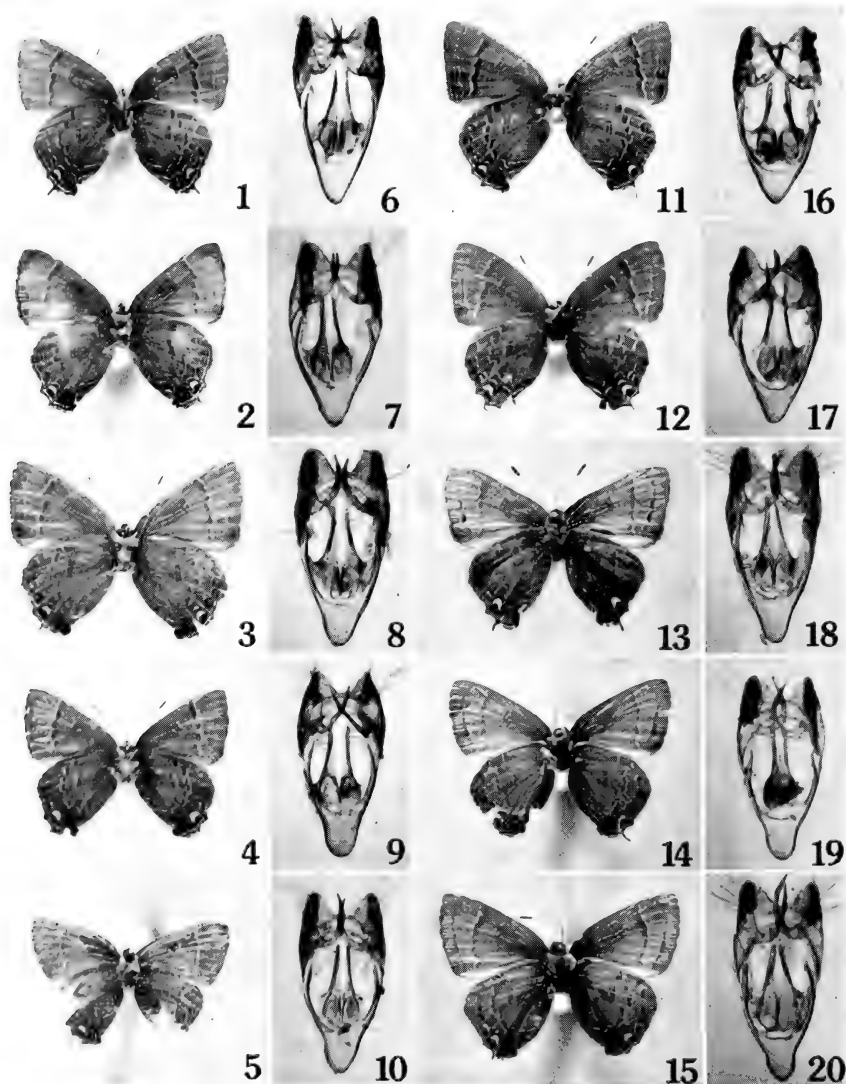
* Chi-square for three df = 0.344; $p = .050$; association is random (methods from Guenther, 1965).

These procedures permit a test of the hypothesis that *S. boreale* represents a wing-pattern variant of *S. falacer* and, therefore, that the two are genitally indistinguishable. If this hypothesis is correct, one would expect to find the same ratio of genitalic types in each wing pattern class as in the total sample. The ratio for the total sample was 51 type B:43 type F, or 0.543:0.457. Table 1 compares the wing-pattern determinations with the genitalic determinations for the same specimens, listing expected and actual genitalic type totals for each wing type. A Chi-square test of the data from Table 1 demonstrates that the hypothesis may be accepted at the 95% confidence level.

It must be stressed that Lafontaine gave no biological criteria for considering *S. boreale* to be a distinct species, and its status is based entirely on phenotypic characters of dead specimens. Therefore, testing the validity of *S. boreale* depends on utilizing Lafontaine's explicit characters in a detailed examination of dead specimens.

The genitalia of these *Satyrium* deserve particular attention. The sole genitalic character cited in Lafontaine's redescription of *S. boreale* is the shape of the saccus. In *S. boreale* the saccus "narrows evenly throughout its length," whereas in *S. falacer* it is "strongly constricted subbasally." Figures of male *S. falacer* genitalia in the literature show considerable variation (Forbes, 1960; Klots & Clench, 1952; Lafontaine, 1970). The genitalia of a male of *S. falacer* as figured by Forbes are intermediate between those figured by Lafontaine for *S. boreale* and *S. falacer*, and the saccus of *S. falacer* shown by Klots & Clench is much broader than in either of the former figures. Because of the variability of the diagrams cited above, short notes were kept on each dissection, e.g., "constriction consistent w/Forbes."

In the genitalia examined, those with the saccus intermediate between Lafontaine's *S. boreale* and Forbes' *S. falacer* are more numerous (37 of 94) than either distinct type F (28 of 94), or distinct type B (29



Figs. 1-5. Males of *Satyrium "boreale"*: 1, Southford Falls State Park, New Haven Co., Conn., 2 July 1975, L. F. Gall & D. F. Schweitzer; 2, same data; 3, West Rock, New Haven Co., Conn., 4 July 1975, L. F. Gall; 4, Southford Falls State Park, New Haven Co., Conn., 4 July 1975, L. F. Gall; 5, West Rock, New Haven Co., Conn., 19 July 1958, W. B. Watt.

Figs. 6-10. Genitalia of same specimens in Figs. 1-5.

Figs. 11-15. Males of *Satyrium falacer*: 11, Southford Falls State Park, New Haven Co., Conn., 4 July 1975, L. F. Gall; 12, Southford Falls State Park, New Haven Co., Conn., 2 July 1975, L. F. Gall & D. F. Schweitzer; 13, Dousman,

of 94) genitalia. These genitalic intergradations were observed for both groups sorted by wing pattern. Representative series of the intergradations appear along with the specimens from which the genitalia came in Figures 1-20. Also, 13 specimens show saccus characters in strong contradiction to their respective wing patterns: 8 have the type B saccus and type F wings, *sensu* Lafontaine, and 5 have the reciprocal.

Four other observations warrant attention. First, in Lafontaine's redescription of *boreale*, he stated that the posterior (6th) spot of the subterminal lines on the primaries shows "a trace of white only, never with any trace of black." I have looked at those specimens which I termed type B wing pattern under a dissecting microscope and have always noted at least three, often as many as nine or ten, dark scales in this area. In a specimen in the Peabody Museum determined by Lafontaine as *S. boreale* (taken 3 July 1965, Ottawa, Ontario, leg. J. D. Lafontaine), I noted four dark scales present; this specimen proved to have a type F saccus. Secondly, a captive female of type B wing pattern (taken at UV light, 3 July 1975, Southford, Connecticut, leg. D. F. Schweitzer) laid 8 eggs on shagbark hickory, *Carya ovata* (Mill.) K. Koch, a food plant of *S. falacer* in Connecticut. The female was kept alive for 15 days in a flight cage containing red oak, scrub oak, white oak, shagbark hickory, butternut, beech, and an ash. Third, I found no difference in the ostium bursae or signum between four females with type F wing pattern and four females with type B wings (Illinois, 3; Connecticut, 2; Massachusetts, 2; and Maryland, 1). Lastly, W. J. Holland (1930) shows in Plate 54, Fig. 21, a specimen of *S. falacer* (= *Thecla calanus*) with ideal type B wing characters.

SUMMARY

The data show that no correlation exists between the wing pattern and saccus characters on which *S. boreale* was based. No evidence is presently available to support the claim that *S. boreale* is a distinct species. The *S. boreale* characters appear to fall within the normal pattern of variation of *S. falacer*. The data also show the extreme phenotypic variability of *S. falacer*. It is possible that the *S. boreale* characters predominate in the north or north-central part of the range

←

Waukesha Co., Wisc., 8 July 1950, N. Euting; 14, Greenwich, Fairfield Co., Conn., 22 June 1941, leg. Starrett; 15, Greenwich, Fairfield Co., Conn., 15 July 1940, leg. Starrett.

Figs. 16-20. Genitalia of same specimens in Figs. 11-15.

of *S. falacer*, in which case the name might be preserved for the end of a clinal trend.

ACKNOWLEDGMENTS

I wish to thank Dr. Charles L. Remington for his help in preparing this paper. I also wish to thank Dale F. Schweitzer for the use of his specimens and his helpful discussions on *Satyrium*. Lastly, thanks to David G. Furth for his technical assistance and sometimes pointed, but lighthearted, encouragement.

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OIKETICUS TOUMEYI: A BAGWORM MOTH NEW TO THE TEXAS FAUNA (PSYCHIDAE)

In the first compilation of bagworm moths (Psychidae) of Texas, Jones & Park (1928, Tex. Agr. Exp. Sta. Bull. 382: 36 p.) listed 13 species that were then known to occur in the state with three additional species to be anticipated. One of these anticipated species was the mesquite bagworm, *Oiketicus toumeyi* Jones. At that time the species was known only to be "widely distributed in southeastern Arizona." Thirty-six years later, *O. toumeyi* has not yet been reported from Texas (Davis 1964, Bull. U.S.N.M. 244: 233 p.), although it was known from Las Cruces, New Mexico, some 40 km from the Texas-New Mexico line.

On 24 October 1970, a single bag containing a live larva was collected on ocotillo (Fouquieriaceae: *Fouquieria splendens* Engelm.) in Presidio, Presidio Co., Texas on the Rio Grande River. The bag measured 62 mm in length and 12 mm at greatest width. The bag was only slightly ornamented with ocotillo thorns and looked quite similar to the bag illustrated by Davis (*op. cit.*, Fig. 98), which had been reared on mesquite. The present report is also a new host plant record for *O. toumeyi* (Davis lists nine other food plants).

The collection of *O. toumeyi* from Presidio indicates that this species most probably occurs over a widespread area of the southwestern United States and northern Mexico, *albeit* sporadically.

I wish to thank D. Otte, who collected the specimen.

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THE GIANT BLASTOBASID MOTHS OF YUCCA
(GELECHIOIDEA)

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Members of the family Blastobasidae are mostly small and uniformly drab moths which are characterized by bands of stout spines on the abdominal tergites. The forewings are often gray or brownish with one or more transverse bands of whitish. Species of subfamily Pigrinae are usually less than 12 mm in wingspread and have small or minute labial palpi, and often their forewings are yellowish or brownish, unicolorous or marked by a straight, transverse band. By contrast Blastobasinae are mostly larger, exceeding 12 mm in wingspread, with gray forewings, frequently showing a chevron-shaped pale marking. Their labial palpi are of the typical gelechioid form, elongate and strongly upcurved, reaching the crown or higher.

Taxonomic relationships within the family are only preliminarily known because no comprehensive assessment of genitalic characters has been attempted. The state of knowledge for the North American fauna is as poorly documented as that of any sizeable group of Microlepidoptera. The genera are based on wing venation and secondary male characters (Dietz, 1900, 1910; Forbes, 1923) and need to be readjusted by use of genital features. Preliminary steps in this direction were taken by McDunnough (1961), who based his decisions in proposing two new genera on too little material. About 100 species are described, but probably at least twice that many are represented in collections.

In 1974 I examined all types of Nearctic Blastobasidae at the National Museum of Natural History and Museum of Comparative Zoology (Harvard) (about 70% of the names) in order to develop a framework for biological studies of western species. Dissections of virtually none of the types have been made, and a number of Chambers or Dietz types are lost or are without abdomens, which will complicate matters for future students, as will Dietz's species concepts which were typological and imponderably fine-lined or heterogeneous from one time to another. In general it appears that considerable synonymy will be necessary among species of eastern North America, especially in the Pigrinae, while the western fauna remains largely undescribed, and the few species that have been named probably are valid.

Larvae of Blastobasinae are characterized by a well-developed sub-

mental pit; otherwise they resemble those of the scavenger group of Oecophoridae. Species for which habits have been studied feed in a wide variety of situations, mostly associated with detritus, often in nests of external feeding caterpillars or in galleries of insect borers. Rearing records include flower or seed heads of sumac (Forbes, 1923), Labiatae, Leguminosae, and Dipterocarpaceae (Fletcher, 1920, 1933); in acorns usually but not always following weevil borings (Craighead, 1950); a variety of conifer cones and foliage in association with various moth larvae (Fletcher, 1920; Lyons, 1957; Keen, 1958; Powell unpubl. data); in fallen fruit of *Ficus* (Fletcher, 1920), coffee (Busck & Oliviera, 1925), palm (Common, 1970) and apple mummies (Forbes, 1923); and in association with coccid colonies (Riley, 1887; Essig, 1916; Costa Lima, 1945; Fletcher, 1920; Forbes, 1931). However, in at least one example a species thought to be a predator was later proved to be a general feeder (Basinger, 1924). One species is said to be a gall maker (Costa Lima, 1945 after Brethes, 1917), a relationship that needs confirmation.

The general conclusion that one reaches is that larvae of most species are opportunists, with colonies basically established as scavengers, but individuals feeding in unaffected plant tissue when convenient or even acting in a predator role when a susceptible prey such as scale insects, beetle larvae (Lyons, 1957) or moth pupae (Keen, 1958) are encountered.

Apparently the biology of no member of the Pigritinae has been recorded. I reared *Pigritia arizonella* Dietz from root crowns of *Chrysothamnus* (Compositae) which were tunnelled by larvae of Eucosmini and Cochylidae (Hot Creek, Mono Co., Calif., VII-11-68, J. Powell no. 68G22). Although the feeding habits of *P. arizonella* were not observed, the record suggests that species of this subfamily also are scavengers, but feed on the ground or in subterranean situations. Thus their larvae have been overlooked because North American insect biologists have tended to ignore this ecological horizon.

In some situations species of *Holcocera* are general scavengers which exploit various habitats. For example, at Dune Lakes, San Luis Obispo County, California, I reared one species from bacterial cankers on *Salix*, abandoned nests of Lepidoptera on *Baccharis* and occupied ones on *Eriogonum*, and from sporophores of Polyporaceae used by ciid beetles. In general, however, data are too preliminary to permit conclusions about habitat specificity because the taxonomy is incomplete and because there are few rearing records relative to the number of species for which adults are known.

Holcocera gigantella was described from Colorado by Chambers (1876), who found the adults perched and mating on leaves of yucca. The biology of this species appears to be exceptional in that a specific habitat is used and prior insect colonies may not be a necessity. Widely disjunct populations showing varying degrees of differentiation have been discovered in association with Agavaceae. Larvae feed in *Yucca* inflorescences after the pods are developing and in flowers of *Agave*.

Some information on the biology of *H. gigantella* has been given elsewhere (Powell & Mackie, 1966). During a study of the moths associated with *Yucca whipplei* larvae were found in large numbers in old pods and in green fruit prior to seed maturation. At one seaside locality in southern California there appeared to be continuous generations. Pupae that produced adults within a few days were collected in February, March, July, and October.

A second species, described below, occurs sympatrically with *H. gigantella* in southern Arizona in association with *Yucca schottii*. Although the new species lives in the same habitat and also is one of the largest Nearctic blastobasids, the two may not be phylogenetically closely related. Markedly different morphological characteristics, especially in female genitalia, are exhibited by the two. The present clarification of the status of these blastobasids provides background information for the *Y. schottii* study as well as a name for the second species.

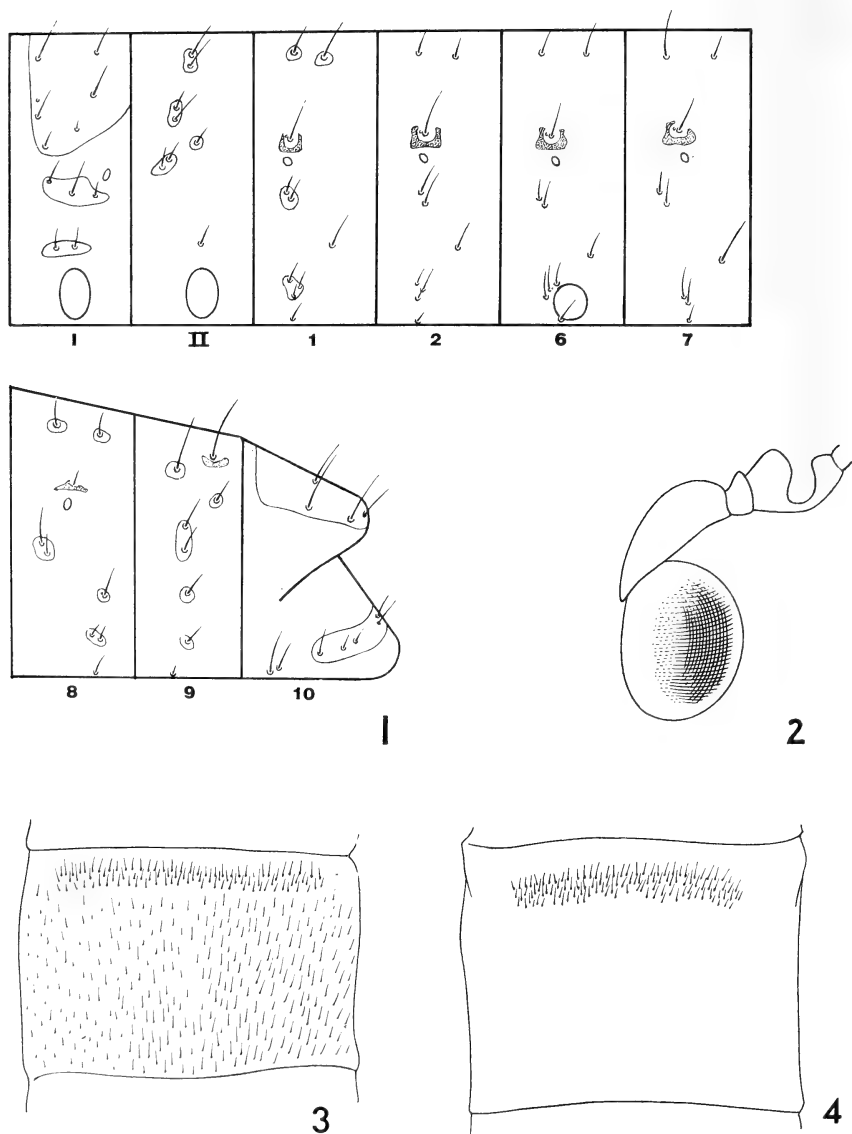
Holcocera gigantella (Chambers)

Blastobasis gigantella Chambers, 1876, Can. Ent. 8: 219.

Holcocera gigantella; Dyar, 1903, Bull. U.S. Natl. Mus. 52: 529; Dietz, 1910, Trans. Amer. Ent. Soc. 36: 29 (taxonomy); Powell & Mackie, 1966, U. Calif. Publ. Ent. 42: 41 (biology).

This is the largest Nearctic blastobasid. The forewings are gray with variable, longitudinal blackish markings.

Male. Length of forewing 11.1–14.7 mm. **Head:** Labial palpus moderately elongate, strongly upcurved, exceeding crown; II segment length 1.1–1.3 times eye diameter; III = 0.65–0.70 as long as II; smooth scaled, whitish with scattered dark gray scales. Antennal scape elongate, length 0.9 eye diameter, broadened distally; 2nd segment short, broad, notched dorsally; 3rd segment claw-shaped, greatly broadened basally with a deep, rounded dorsal notch distally (Fig. 2); setae of shaft elongate, length greater than diameter of 4th and succeeding segments. Scaling of front and crown appressed, whitish to grayish. **Thorax:** Dorsal scaling white to gray; underside whitish, legs grayish exteriorly, hind tibia with enlarged, white dorsal fringe. **Forewing:** Narrow, length 4.5–4.9 times width. Ground color whitish to gray, usually with obscure to well-defined longitudinal, blackish lines along the veins, at least on distal half. In the typical form the lines are well-defined from base to apex, distinctly contrasting with the whitish ground and forming a short bar in middle of cell above fold and a transverse line or paired spot at end of cell; more often the markings obscured on basal half, with lines and spots of distal half strongly contrasted on a pale to dark gray ground; rarely with additional infuscation broadening the lines into spots that tend to form



Figs. 1-3. *Holcocera gigantella* (Chambers): 1, setal patterns on thoracic segments I-II, abdominal segments 1, 2, 6-10; 2, outline of antennal segments 1-3, eye, dorsolateral aspect; 3, setation of second abdominal tergite. Fig. 4. *H. paradoxa* Powell, setation of second abdominal tergite (posterior margin at top).

transverse bands at middle and in distal third of wing. Fringe pale gray, without extensions of the longitudinal markings. Underside dark gray, in pale forms with suggestion of whitish lines between veins in terminal area. *Hindwing*: Costal margin moderately excavate on distal third; width at end of cell about equal to forewing. Veins $M_3 + Cu_1$ stalked a varying distance, M_2 free, connate at base of $M_3 + Cu_1$ or from their stem. Base of anal margin and 3A with elongate, whitish ochreous hair tufts. Upperside scaling whitish and roughened on basal third, becoming pale gray and smooth distally; fringe paler, whitish. Underside similar, darker. *Abdomen*: Tergite 1–2 with a dense row of spines posteriorly and scattered smaller spines over whole surface (Fig. 3), 3–7 with compact, narrow posterior spine row only. Scaling shining whitish gray, obscuring the spine rows in fresh specimens. Genitalia as in Fig. 5 (drawn from lectotype, JAP prep. no. 4008, 9 preparations examined); transverse band of gnathos broad, with posterior notch; valva with a basal, triangular-shaped flap; costal process and free portion of sacculus relatively elongate, ca. 0.3 the total length of valva; sclerotized band of aedeagus forming a narrow ring at base.

Female. Length of forewing 11.7–14.7 mm. Essentially as described for male, differing as follows: labial palpus more elongate, II segment length 1.4–1.5 times eye diameter, $III = 0.80\text{--}0.85$ as long as II. Second and 3rd antennal segments unmodified; antennal ciliation short, less than 0.5 segment diameter. Forewing pattern variable, tending to be darker than male in any given population; forewing broader, length 4.3–4.6 times width. Genitalia as in Fig. 7 (drawn from paralectotype, JAP prep. no. 4009, 6 preparations examined); base of ductus bursae unmodified, without spiculae or scobination, gradually enlarged and abruptly turned before entering corpus bursae; signum broad, with a deep median crease, smooth surfaced.

Lectotype. Male, by present designation; Colorado, in MCZ; bearing labels: "Chambers Color.," "Type 1551," "Blastobasis gigantella Col." (the last in Chambers' handwriting); and Genitalia 4008, JAP '75. There are two females and a specimen lacking metathorax and abdomen with the same data, in MCZ, and a specimen in poor condition with the Chambers determination label in NMNH. In the original description Chambers stated that he had met with the species only once, on the road to Monument Park, about 3 mi. N of Colorado Springs.

The type series is of the phenotype with whitish forewings marked by strongly contrasting dark longitudinal lines. Most specimens from certain California localities (San Luis Obispo Co., Santa Barbara Co., San Bernardino Mts., Mojave Desert) are similar, usually with more blackish markings. The material from San Diego County and Baja California is generally darker, most individuals having a uniform dark gray ground marked by diffuse longitudinal lines. A few southern California specimens and those from southern Arizona are intermediate, having a pale gray ground and with the dark markings more well-defined than in most San Diego examples and more extensive than in the typical form, tending to form transverse spots. The single specimen from Wyoming is similar to the types, which are the largest specimens. Those from California are moderately large, ranging up to 14.4 mm in forewing length; the short series from Arizona average smaller, ranging to 12.7 mm in the male and 13.4 mm in the female. Two males from Baja California reared from *Agave orcuttiana* flowers are the smallest (FW 11.1–11.7 mm), possibly a function of the food (flowers vs. pods) or rearing conditions, but they do not differ structurally.

Larva. The following diagnosis of the larval characteristics is based on a composite series of 20 last instar individuals from Cardiff, San Diego Co., California, collected in June 1963, and March and October 1967 (J. Powell nos. 63F13, 67C36 and 67K80).

Last instar larva: Length including head 13.0–23.8 mm (distended in KAAD preservative). *Head*: Width of head capsule (HC) 3.2–3.8 mm; deep amber to

orange brown dorsally with faint darker mottling; adfrontal plates narrow and irregularly bordered exteriorly. Setal arrangements as in *H. chalcfrontella* (Clemens) (MacKay, 1972). Submental pit well-defined, the submentum sclerotized laterally and posteriorly to the pit. *Body*: Thoracic shield and rings below SD₁ seta of Th3 to Ab7 dark amber, darker than the pinacula and anal shield, which vary in color independently, from yellowish to brown. Integument variably mottled with pale to dark purplish, forming on abdomen 3 broad, longitudinal bands, 2 in SD area and a weaker one in L enclosing spiracles; the intervening D and SD bands (latter enclosing SD₁ setae and their sclerotized crescents) usually unpigmented, but white in intensely colored individuals. Setal arrangements as in Fig. 1. Abdominal spiracles slightly oblong, tilted dorso-anteriorly, about 2× the size of most setal bases. Abdominal crotchets in a circle, 38–46 (usually 38–42), partially biordinal in an inconsistent pattern. Anal crotchets 27–35, partially biordinal to nearly triordinal. Anal fork absent.

Larvae collected in October were smaller (HC: 3.2–3.35 mm; length 13.0–16.7 mm) and were more deeply pigmented. Samples taken in March and June consisted of larger individuals (HC: 3.4–3.8 mm; length 16.0–23.8 mm) and contained no specimens with white longitudinal markings between the purplish bands.

In larval characters *H. gigantella* does not differ appreciably from the much smaller *H. chalcfrontella* as characterized by MacKay (1972) except in pigmentation and by the oval, relatively larger spiracles in *H. gigantella*.

Material examined. ARIZONA: Bog Springs, Madera Cyn., Santa Rita Mts., VII-10/26-64 (adults in flowers and reared from fruit of *Yucca schottii*; D. R. Davis); VII-30-73 (1 ♀ at light; Coville, Szerlip and Powell); 2 mi. SW Portal, Cochise Co., VII-25-72 (1 ♀ in flowers of *Y. schottii*; Powell). CALIFORNIA: short series, unknown locality in Los Angeles Co., VI-VII-1888 (reared from *Y. brevifolia*; Coquillett and Riley). Large series from various localities in association with *Y. whipplei*, as follows: Cardiff, San Diego Co. (reared from old and green fruit); 7 mi. E Morro Bay, S. L. O. Co., VI-23-65 (at light, Buckett); Mt. Lowe, VI-6-24 (Piazza) and 2 mi. NW Devil's Punchbowl, L. A. Co., V-1-68 (at light; Opler, Powell); Forest Home (reared; Dammers) and Mill Creek, San Bernardino Co., (reared; Keifer); 3 mi. N Refugio Beach, Santa Barbara Co., VI-21/28-65 (at light; Buckett and Powell). COLORADO: type series, cited above. WYOMING: 6 mi. NW Newcastle, Weston Co., VII-13-65 (1 ♀ at light; Hodges). MEXICO, BAJA CALIFORNIA NORTE: 2 mi. E El Rosario, III-26-73 (reared from flowers of *Agave orcuttiana*; Doyen and Powell); 5 mi. E El Rosario, III-18-72 (1 ♀ at light; Doyen and Powell).

In addition there is a series of specimens from Hidalgo, Mexico, which differ by having the forewing nearly immaculate white (Ruins of Tula, 7500', VII-31-63, reared from yucca pods; D. R. Davis). Despite the differing phenotype and widely disjunct distribution, I did not find structural features to distinguish this population from *H. gigantella* (two genitalia preparations of each sex examined). The forewing in most individuals is nearly entirely pale grayish white, with only the two dark dots at the end of the cell which are characteristic of the genus. One female is slightly darker grayish, showing faint longitudinal grayish lines.

Two larvae from the intervening geographical region were examined. These were collected from fruit of *Yucca filifera* on the road to Salinas, 79 km NW of San Luis Potosi, 18 June 1963, by L. E. Caltagirone. They are distinguishable from *H. gigantella* as characterized above from California only in having the integumental purplish pigmentation restricted to more well-defined SD and L bands.

***Holcocera paradoxa* Powell, new species**

A moderately large blastobasid having pale forewings with blackish longitudinal lines and two black dots at the end of the cell, and short antennal ciliation in the male.

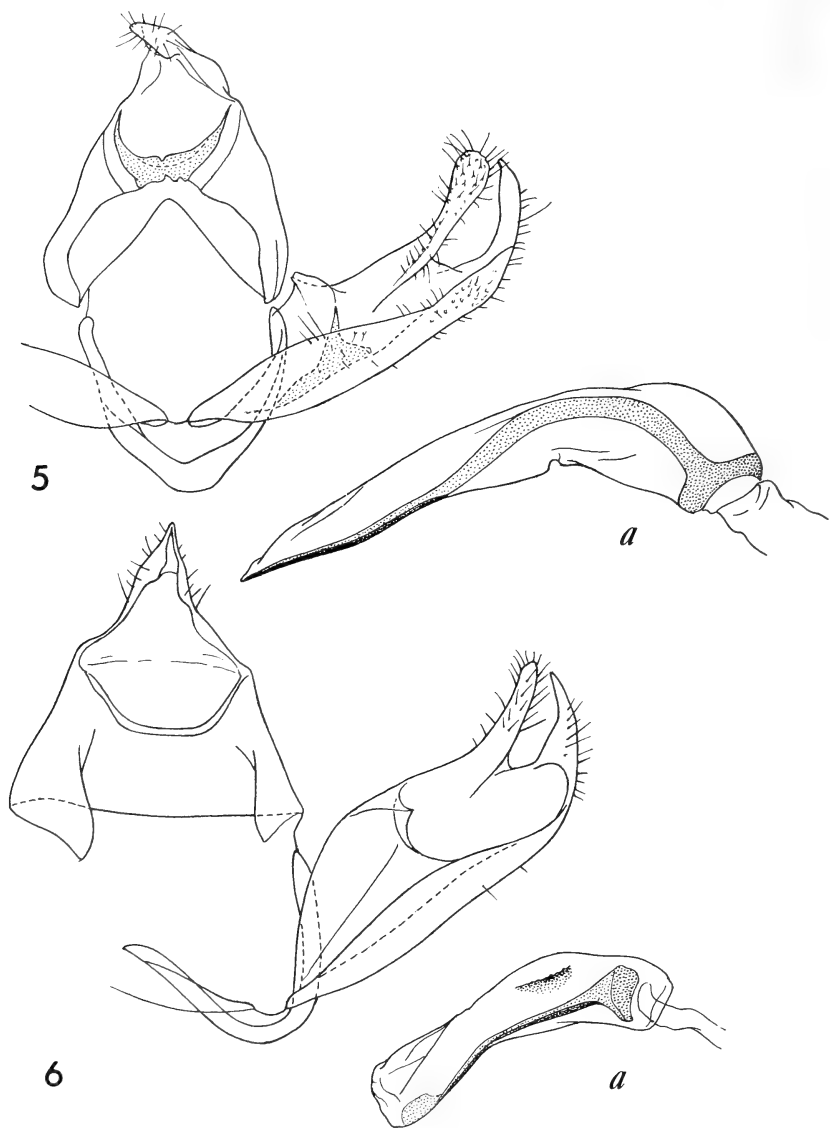
Male. Length of forewing 9.7 mm. *Head:* Labial palpus elongate, strongly curved, exceeding crown; II segment length 1.4 times eye diameter; III = 0.9 as long as II; smooth scaled, whitish with scattered dark scales. Antenna with scape elongate, subequal to eye diameter, broadened with elongate pecten on anterior margin, 2nd segment short, less than 0.25 length of 1st; 3rd claw-shaped, broadened basally with a deep notch on dorsal side distally; short ciliate, the setae less than 0.5 diameter of 4th segment. Scaling of front and crown whitish tan. *Thorax:* Dorsal scaling whitish tan with scattered brownish. Venter whitish tan; legs speckled with dark gray exteriorly; hind tibia with enlarged dorsal fringe. *Forewing:* Narrow, length 4.4 times width. Scaling whitish tan, dark gray between the veins, forming moderately distinct longitudinal lines, especially on costal half and beyond cell; a whitish blotch at end of cell enclosing two dark dots at upper and lower corners of cell. Fringe pale grayish. Underside dark gray to margins; fringe pale. *Hindwing:* Slightly narrower than forewing at end of cell; vein M_2 separate, nearly adjacent to connate base of M_3 and Cu_1 . Dorsal scaling shining whitish gray. Fringe broad, whitish ochreous. Underside gray, fringe as above. *Abdomen:* Scale coloration not recorded. Dorsal spine bands narrow, compact, well-defined (about 3–4 spines wide) on segments 2–7 (Fig. 4); basal segment without spines. Genitalia as in Fig. 6 (drawn from holotype, JAP prep. no. 3874, one preparation examined); transverse connection of gnathos narrow without posterior notch; valva with costal process and free portion of sacculus relatively short, ca. 0.25 valva length; sclerotized median fold relatively elongate, 0.5 valva length; aedeagus with sclerotized band broad at base.

Female. Length of forewing 10.6 mm. Essentially as described for male, differing as follows: 2nd and 3rd segments of antenna not modified, antennal ciliation short. Forewing pattern more diffuse, the dark lines and spots less distinct. Hindwing with veins $M_3 + Cu_1$ stalked, the stem about 0.25 the length of Cu_1 ; M_2 connate with $M_3 + Cu_1$ stem. Abdomen with dorsal spine rows on segments 2–7. Genitalia as in Fig. 8 (drawn from allotype, JAP prep. no. 3847, one preparation examined); sterigma weakly sclerotized, scobinate; ductus bursae narrow throughout, rugose but not spiculate; signum a broad, concave plate, densely spurred interiorly.

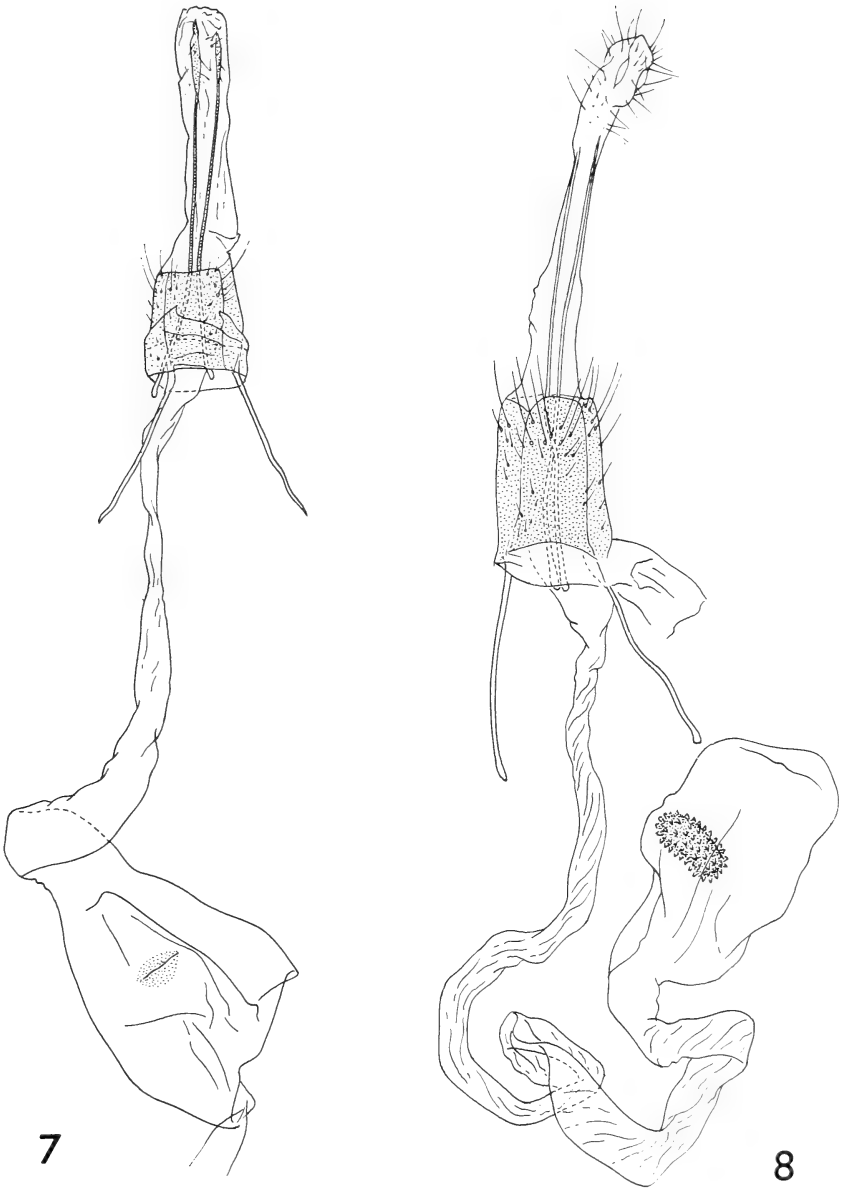
Holotype. Male, Arizona, Madera Canyon, Santa Rita Mountains, 6 June 1968, reared from remnants of 1967 pods *Yucca schottii*, emgd. 24 September 1968 (J. Powell no. 68F47). Allotype female, same locality, 3 October 1968, reared from 1968 pods *Y. schottii*, emgd. 3 June 1969 (J. Powell no. 68K15). Holotype placed at the California Academy of Sciences on indefinite loan from the Essig Museum of Entomology, University of California, Berkeley, which retains the allotype.

The peculiar wing venation in the hindwing of the male is outside the range of that shown in a long series of males of *H. gigantella*, which although somewhat variable, always have $M_3 + Cu_1$ at least short-stalked. The female venation in *H. paradoxa* is typical of *Holcocera* and *Holcocerina* as defined by McDunnough (1961), but the female genitalia in these two species possess a mixture of features of the two genera. The status of *Holcocerina* will have to be reassessed by comprehensive study of North American species. The new species is most similar to *H. gigantella* among Nearctic blastobasids for which salient features have been described. *H. paradoxa* differs by its smaller size, more elongate labial palpus, and short antennal ciliation in the male, and compact spine row on abdominal segment 2. In genitalia, *paradoxa* is distinguished by its narrow gnathos band and relatively short free parts on the valva and by the distinctive features in female genitalia: sterigma form, ductus form and surface texture, and the spurred signum.

Preserved larvae believed to represent *H. paradoxa* were examined from the type locality (Oct. 1968, Sept. 1969, Aug. 1970), Pena Blanca Lake area, Santa Cruz Co., Ariz. (Sept. 1969) and Paradise Road, Chiricahua Mts., Ariz. (Aug. 1971). All were collected as eggs or larvae from green pods of *Yucca schottii*. These larvae



Figs. 5-6. *Holcocera*, male genitalia, ventral aspect, valvae spread, aedeagus (a) removed and shown in lateral aspect: 5, *H. gigantella* (Chambers), lectotype; 6, *H. paradoxa* Powell, holotype.



Figs. 7-8. *Holcocera*, female genitalia, ventral aspect: 7, *H. gigantella* (Chambers), paralectotype; 8, *H. paradoxa* Powell, allotype.

do not differ structurally from those of *H. gigantella*, as characterized above from California. However, Arizona specimens differ by lacking most of or all of the integumental pigmentation. The color and extent of sclerotization of the prothoracic shield and kappa group pinaculum is similar in the two geographic samples, but the extensive purplish markings that form longitudinal bands in *H. gigantella* are lacking or represented by only faint traces in *H. paradoxa*. The dark sclerotized crescents (SD₁) of the metathorax and abdominal segments 1-7 and the conspicuously brown pinacula in *H. gigantella* are unpigmented in *H. paradoxa*. The integumental pigment is darker in the penultimate and antepenultimate stadia in *H. gigantella*. These stages lack integumental markings in the Arizona populations, so instar differences between collections is not a factor in the two forms.

After adults were reared from small samples of pod material in 1968, larger collections were made in September 1969, but all larvae died, probably due to overheating during field transit. The larval habits of *H. paradoxa* are briefly described elsewhere (Powell, 1976).

ACKNOWLEDGMENTS

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Cooperation by J. F. Lawrence, Museum of Comparative Zoology, Harvard and R. W. Hodges, National Museum of Natural History, Washington, D.C. enabled study of specimens in those institutions.

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NOTES AND NEWS

Recent Letter

Dear Dr. Godfrey,

With reference to Mr. Manley's note on "The 'greasy' wing gene of *Utetheisa ornatrix* (Arctiidae)" (1975, J. Lepid. Soc. 29: 77), I do not think that any special significance should be attached to the 1:1 ratio in females *ex* various collections, except that it shows that the aberration is confined to the female, but whether sex-linked or sex-controlled can only be ascertained by breeding. It is most unusual for the proportion of an aberration to the type in museum collections to correspond with the proportion in nature; there is an inevitable bias in favour of the aberration. Also no inference as regards dominance can be drawn from such figures, as many morphs, genetically dominant, are far rarer than the recessive allelomorph in nature. A good example is f. *salaami* Suff. of *Papilio dardanus* Brown, which is far rarer than f. *hippocoon* F., to which it is dominant.

Dr. Sargent's experience with *Papaipema duovata* (1975, J. Lepid. Soc. 29: 9) appears to confirm the comment made by J. W. Tutt, the famous English entomologist, early in the century "that no species is rare if you know where to look for it."

An entomologist, working with light, both mercury vapour and incandescent, would be quite justified in concluding that the sphingid *Nephele peneus* Cr. did not occur in Mombasa. Its congeners *argentifera* Wlk., *bipartita* Btlr., *funebis* F. and *comma* Hpffr., all visit light freely, whilst *aequivalens* Wlk., *ocnopion* Hbn. and *rosae* Btlr. occur more rarely, but during 20 years collecting I have known a single *peneus* to visit light. Yet it is quite common and an examination of its foodplant in the proper season will always provide large numbers of ova and larvae at all stages of growth.

D. G. SEVASTOPULO

GENERAL NOTES

A SURVEY OF THE SPHINGIDAE OF SANIBEL ISLAND, FLORIDA

Sanibel Island, which lies ca. 3 mi. off the coast of Florida at Fort Myers, is one of a series of islands that form a chain reaching from north of Charlotte Harbor to slightly south of the mouth of the Caloosahatchee River. The island, which is roughly 12 mi. long by 3 mi. wide at its widest point, is currently suffering considerable habitat destruction from commercial development. However, large areas of relatively unspoiled land still remain. A survey was conducted to obtain data on the Sphingidae of Sanibel Island, including the relative abundance and feeding behavior of each species. The recent rapid commercial development of much of the island makes these data, obtained before this latest and largest wave of habitat destruction, especially important.

METHODS

Two methods of data collection were utilized in making this survey. The primary method involved observing and collecting specimens as they fed at flowers (mainly sea periwinkle, *Vinca rosea*), and collecting at lights was used as a secondary method.

Three major sites were used in the primary method. Two of these sites were large open areas, largely covered with *V. rosea*. Both of these sites were within 300 yd. of the Gulf of Mexico but were surrounded by large trees so that ocean breezes, which would influence feeding behavior, were negligible. The third site was farther inland. This site was partially covered with *V. rosea*, but numerous bushes and small trees were scattered over it as well. The sites were generally checked at dusk and dawn (many Sphingidae are crepuscular) and were often checked continuously for several hours beginning at dusk. Most species were easily disturbed by artificial light. Therefore, the author collected in the dark, using movement of the flowers to locate specimens.

Specimens collected at lights were mainly obtained by collecting in the parking lot of a shopping center located roughly 1 mi. inland from the Gulf of Mexico. This parking lot was brilliantly illuminated by a series of mercury vapor lights on tall posts. The author also obtained specimens from lights located at many other points on the island, these lights being patrolled periodically by car.

This survey was conducted by the author during the entire months of August of 1961 through 1966; June 20 through August 28, 1967; the latter halves of August of 1968 and 1969; the first half of August, 1971; and one week each in December, 1960 and December, 1966. Most of the specimens collected during this survey are in the author's private collection.

RESULTS AND DISCUSSION

One of the most interesting results of this survey concerns feeding behavior of the different species. Each species has a characteristic pattern of flight while feeding. Some species (e.g., *Madoryx pseudothyreus* (Grote)) stay under leaves and between stems whenever possible, whereas other species (e.g., *Pachylia ficus* (Linnaeus)) avoid such situations and remain in the open, and still others (e.g., *Manduca brontes* (Drury)) seemingly have no preference in this regard. Furthermore, some species skip from one group of flowers to another as a normal part of feeding (e.g., *Enyo lugubris* (Linnaeus)), whereas other species feed on nearly all the flowers in one area before moving to another (e.g., *Erinnyis obscura* (Fabricius)). Another interesting behavioral difference involves movement of flowers while feeding. Each species moves a flower in a characteristic manner as it hovers over the flower to feed, interspecific differences in this regard probably being due to dif-

ferences in proboscis length and body size. The differences in flight patterns and flower movements are consistent enough to allow generally accurate specific identification based on these factors alone, although considerable practice is needed to master this art.

A list of species collected and observed by the author during this survey follows. Names used are those found in Hodges (1971, Sphingoidea. In R. B. Dominick, *et al.*, The moths of America north of Mexico, fasc. 21). Times are Eastern Standard Time. Comments on such things as behavior and abundance are included for each species. The author believes that this list is essentially a complete one for the month of August. However, it is, of course, quite possible that other species are present at different times of year.

1. *Agrius cingulatus* (Fabricius) is common both at lights and at feeding sites, especially during the latter part of August. In general, this species feeds only well after dark.

2. *Cocytius antaeus* (Drury) is rare during August. The author collected only three specimens during the survey, all at lights. Two additional specimens were observed flying just before dusk. Large quantities of bright yellow pollen were found in the proboscises of two of the collected specimens, but the author never observed this species feeding.

3. *Manduca sexta* (Linnaeus) is very common at lights and common at feeding sites.

4. *Manduca quinquemaculata* (Haworth) is abundant at lights and common at feeding sites. It is not unusual to have 10 or 12 specimens in view simultaneously at lights.

5. *Manduca rustica* (Fabricius) is common at lights and moderately common at feeding sites. It generally feeds well after dark, in August often between 2200 and 2300 hr.

6. *Manduca brontes* (Drury) is common at feeding sites and somewhat less common at lights. It generally begins feeding shortly after dusk.

7. *Pseudosphinx tetrio* (Linnaeus) is rare. The author collected only one specimen during the survey. This specimen was feeding on *V. rosea* at ca. 2230 hr.

8. *Erinnyis alope* (Drury) is uncommon but is found at feeding sites and at lights with about equal frequency. Some individuals are extremely difficult to approach while feeding, whereas others at the same sites and under apparently similar conditions are relatively easy to approach.

9. *Erinnyis ello* (Linnaeus) is common at lights and very common to abundant at feeding sites. It usually starts to feed just as true darkness begins.

10. *Erinnyis obscura* (Fabricius) is one of the three most abundant sphingid species on Sanibel Island. It is abundant at lights and incredibly abundant at feeding sites. The author once had 29 specimens of this species in view simultaneously, and groups of 12 to 15 specimens are common. *Erinnyis obscura* begins feeding well before dark, usually as the sun sets, and is one of the first species to begin feeding each night.

11. *Phryxus caicus* (Cramer) is variable in August, sometimes locally common and at other times quite uncommon. This species is unusual in that it barely moves the flower as it feeds.

12. *Pachylia ficus* (Linnaeus) is uncommon to rare. It begins feeding before sunset and often will fly erratically for distances of several hundred feet, ending the flight at a flower a foot or so from the one it fed on just prior to the flight. The species has two modes of flight. When flying at normal speed the abdomen extends out behind the thorax as it normally would, but, when slowing down or flying slowly, the abdomen is bent toward the ground and the stroke of the wings changes, the hindwings being used to reduce speed by adding drag. This change in manner of flight is extremely obvious during the erratic "feeding flights" described above.

13. *Madoryx pseudothyreus* (Grote) is generally uncommon. When feeding, it

hovers under leaves or between stems whenever possible and, because of this habit, may easily be overlooked by the collector.

14. *Aellopos tantalus* (Linnaeus) is uncommon and diurnal, feeding on several species of flowers.

15. *Enyo lugubris* (Linnaeus) is one of the three most common sphingid species on the island. It begins feeding well before dusk and is not uncommonly found feeding during the day also. As this species flies, it makes a loud whirring noise that sounds similar to the noise produced by a diving nighthawk, *Chordeiles minor minor* (Forster).

16. *Hemaris thysbe* (Fabricius) is diurnal and uncommon. Since its feeding habits are well-known, they will not be treated here.

17. *Hemaris diffinis* (Boisduval) is diurnal and reasonably common. Its well-known feeding habits will not be treated here.

18. *Eumorpha achemon* (Drury) is rare. The author collected only two specimens during the survey, one feeding on *V. rosea* and one at lights.

19. *Eumorpha vitis* (Linnaeus) is fairly uncommon. Specimens feeding on *V. rosea* tend to remain close to the ground and may remain within a small area for several minutes at a time. Feeding begins after nightfall.

20. *Eumorpha fasciata* (Sulzer) is variable, although generally somewhat uncommon. It is more commonly found at feeding sites than at lights and begins feeding at dark.

21. *Cautethia grotei* Henry Edwards is not too uncommon. It begins feeding at dusk and feeds intermittently, well into the night.

22. *Xylophanes tersa* (Linnaeus) is one of the three most common sphingids on Sanibel. It is abundant at both lights and feeding sites. Feeding begins just as the sun sets.

23. *Hyles lineata* (Fabricius) is variable, although, in general, it is moderately common at feeding sites and common at lights. It is often found feeding diurnally, although nocturnal and crepuscular feeding are more common.

Hints on Collecting at Feeding Sites

Collection of feeding sphingids at night requires techniques quite different from those generally employed to collect other Lepidoptera. Therefore, it may be of interest to briefly review the basic techniques involved.

Equipment. Dark clothes are helpful, since light colored moving objects tend to disturb feeding sphingids. The author uses a lightweight net with a 4-ft. handle. Light colored netting should not be used. A series of killing bottles should be tied to a belt in such a way that a bottle can be opened rapidly with one hand. Large corks used in place of screw tops are helpful in this regard. If artificial light is used, it should be extremely weak, since most lights disturb feeding behavior in many species. Unfortunately, most insect repellents repel sphingids; therefore, mosquito repellents can only be used sparingly. If mosquitoes are bad, a headnet offers some protection but reduces vision.

Techniques. The key to successful collecting is to move slowly, stalk, and use a short, rapid stroke to capture specimens. Squatting close to the ground considerably improves the collector's chances of seeing both moving flowers and hovering moths. Identify all moths visible *before* stalking a specimen, and decide which specimen is most desired. Take care not to disturb other moths because one alarmed moth will often dart about and alarm the others. Hold the net low but keep it ready for use. Be sure to hold the net bag so that it also does not alarm specimens. The author holds the netting against the net handle with the first finger of the right hand and does not release it until beginning the capture stroke, which should be short and swift (2 ft. or less) for best results. If killing bottles are worn on the left side, specimens can be transferred to them rapidly from the net. This transfer can largely be done by touch, so that the collector can be bottling one specimen as

he plans his next stalk. Knowledge of the behavior of each species is important in planning captures; some species will come to you if you position yourself properly in the feeding site. If a moth changes its flight pattern and becomes restless, experience is your best guide. Some species will return after such behavior; others will not.

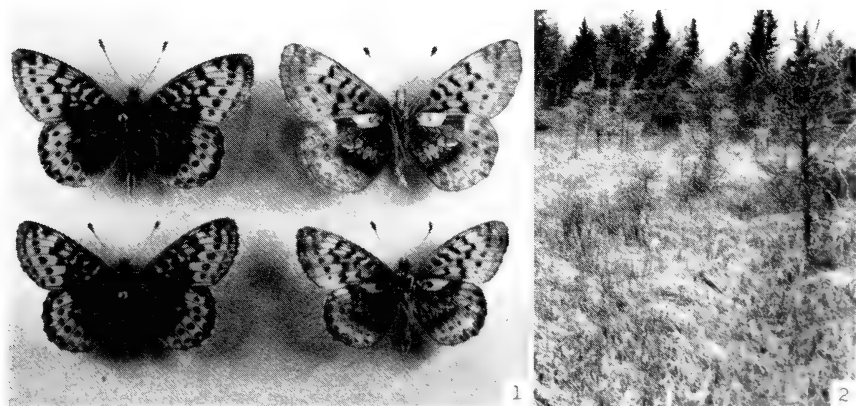
Times to Collect. Each species feeds only at certain times during the night. On Sanibel, one group of species feeds at dusk, a second shortly after dark, and a third group ca. 2½ hr after dark. Practically no species feed between 0100 and 0330 hrs on Sanibel. The dawn feeding schedule is basically the reverse of the dusk schedule, except that some species feed at dusk only.

Selection of a Collecting Site. Obviously, local conditions greatly influence choice of sites. If possible, the site should have large numbers of flowers accessible to the collector. Some species prefer large open areas, and others prefer sites with tall vegetation. One good way to increase the number of species collected is to use several different types of sites and to check each site at various times and under different weather conditions.

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FIRST RECORDS OF *BOLORIA FRIGGA* (NYMPHALIDAE) IN WISCONSIN

During the last week of May 1975, *Boloria frigga* (Thunberg) (Fig. 1) was discovered in a number of northern Wisconsin localities. On 24 May two fresh males were collected at the edge of a wet, open bog in Conover Township, Vilas Co., by George Balogh of Milwaukee. Other specimens were seen farther out in the bog but were not collected. On 25 May we (LAF, RMK) discovered a colony of *B. frigga* in a bog located in Upham Township, Langlade Co. Thirteen freshly emerged males and two females were collected. The next weekend, one of us (LAF) investigated other northern Wisconsin bogs in search of this species. Another colony was found in Lincoln Township, Vilas Co., on 31 May. Four males and one female were taken, and several other specimens were seen. Some of the females observed



Figs. 1-2. 1, *Boloria frigga* (Thunberg) males, Vilas Co., Wisconsin, 31 May 1975 (above), and Langlade Co., Wisconsin, 25 May 1975 (below); 2, bog habitat of *B. frigga*, Vilas Co., Wisconsin.

were somewhat worn. Also on 31 May, two worn males and a fresh female were collected in Bradley Township, Lincoln Co. These specimens, taken by Fay Karpoleon of Eau Claire, were found in the open portion of a large acid bog. These records indicate that *B. frigga* probably exists throughout the northern quarter of Wisconsin wherever there are suitable bogs.

These dates of collection appear to be more advanced than normal, probably due to unseasonably high temperatures during the third week of May. An unusually early *Oeneis jutta* (Hübner) was also taken on 25 May at the Langlade Co. locality. The earliest date that *O. jutta* was collected in neighboring Marathon Co. was 31 May.

Boloria frigga appears to be restricted to open, sedgy sphagnum bogs (Fig. 2). The bogs at all localities tended to be quite wet. At the localities visited by the authors, the bogs supported scattered *Larix laricina* (Tamarack), clumps of *Betula pumila* (Dwarf Birch) and *Salix pedicellaris* (Bog Willow). Also present were *Kalmia polifolia* (Swamp Laurel), *Andromeda glaucophylla* (Bog Rosemary), *Chamaedaphne caliculata* (Leather Leaf) and an occasional *Sarrcenia purpurea* (Pitcher-plant).

The specimens of *Boloria frigga* are presently retained by their respective collectors.

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ADDITIONAL NEW BUTTERFLY RECORDS FROM FLORIDA

Florida continues to be a source of new records of Lepidoptera in spite of burgeoning land development and destruction of the natural habitat. However, some species may benefit from this as certain ornamental plants become more widespread. We report herein one new U.S.A. record (Pieridae), one new Florida record (Lycaenidae), and additional records of some recently reported species.

Pieridae

Phoebis orbis (Poey). A single fresh male of this species (previously unrecorded from the U.S.A.) was taken on 25 April 1973 at about 1200 EST, on Big Pine Key, Monroe Co., Fla. It was captured visiting flowers with other *Phoebis* species, on Sands Rd. across from a pine forest. No others were seen in the area.

P. orbis is illustrated by Lewis (1973, *Butterflies of the World*. Chicago. 312 p.). However, the specimen taken has a milky white ground color rather than the yellow shown by Lewis, and the basal patch on the upper forewing is orange rather than dark yellow.

P. orbis has previously been reported from Cuba and Hispaniola (Scott 1971, J. Res. Lepid. 9: 249-256), and the Florida specimen reported in the present paper is evidently a stray.

Anteos maerula maerula (Fabricius). Five specimens were taken on 31 August 1973 on Big Pine Key, Monroe Co., Fla. These were caught during intermittent rain showers while visiting flowers along the road.

Nymphalidae

Anartia lytrea chrysopelea (Hübner). Six fresh specimens of this recently reported species (Anderson 1974, J. Lepid. Soc., 28: 354-359) were taken on 24 and 25 April 1973, on Big Pine Key, Monroe Co., Fla. Two specimens were deposited in the Carnegie Museum and two in the M. Howard Collection.

Lycaenidae

Tmolus azia (Hewitson). The first specimen of *Tmolus azia* taken in Florida was a worn female on 28 June 1974 in Fairchild Gardens, Dade Co. This butterfly was found on an ornamental acacia. A second specimen, also female, was taken on 27 April 1975 at the same location on *Montezuma speciosissima* Moc. & Sesse (Malvaceae).

A third record of *T. azia* was contributed by Mr. Charles Covell, who captured a single fresh specimen on 12 May 1975 near Homestead, Dade Co., Fla.

T. azia is found in South and Central America extending into the extreme southern portions of Texas and Arizona (Erlich & Erlich 1961, How to Know the Butterflies. Dubuque, Iowa. 200 p.), but there are no records of this species from the Antilles (Scott 1971, J. Res. Lepid. 9: 249-256). *T. azia* may, therefore, represent a recent introduction to Florida, perhaps associated with exotic ornamental plants.

Electrostrymon angelia (Hewitson). This species, also reported by Anderson (1974, J. Lepid. Soc., 28: 354-359), is taken commonly at Fairchild Gardens, Dade Co., Fla., where it is associated with *Derris* sp. (Leguminosae), a group of trees and shrubs native to India. However, immatures have not been found on this plant. *E. angelia* was also taken on 8 May 1975, in a sawgrass marsh located near the junction of U.S. Highway 41 and State Road 27 in Dade Co., Fla.

ACKNOWLEDGMENTS

We wish to thank Dr. Lee Miller of the Allyn Museum of Entomology for help with determination of *Tmolus azia*, *Phoebis orbis*, and *Anartia lytrea chrysopelea* and Dr. Harry Clench of the Carnegie Museum of Natural History for help with determination of *Anartia lytrea chrysopelea*.

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NOCTURNAL ACTIVITY OF A MONARCH BUTTERFLY (DANAIDAE)

Rhopalocera are generally diurnal in habits, even becoming inactive during total solar eclipses (Moucha 1964, J. Lepid. Soc. 18: 109-110). Scattered reports of Rhopalocera at artificial light, including light traps, have indicated some nocturnal activity of these insects (Kendall & Glick 1972, J. Res. Lepid. 10: 273-283 and references therein). Some reports have included pairs in copula (Heitzman 1969, J. Lepid. Soc. 23: 105-106; Chambers 1962, J. Lepid. Soc. 16: 200). However, activity directed toward artificial light may not indicate normal nocturnal activity. Some species collected at artificial light are those normally active at dusk or low light level habitats [*Opsiphanes* by Welling (1963, J. Lepid. Soc. 17: 37-38) and *Melanitis* by Donahue (1962, J. Lepid. Soc. 16: 131-135)]. Diurnal species collected at light traps may well include only specimens that have somehow become disturbed (Kendall & Glick, *op. cit.*).

On 29 October 1971 at the Brackenridge Field Laboratory of the University of Texas at Austin, I observed an adult male monarch, *Danaus plexippus plexippus* L., feeding at inflorescences of shrubby boneset, *Eupatorium havanense* H.B.K. (Compositae), at 2130 CDT. The time of observation was 2 hr 44 min after sunset. Moonlight was apparent but not bright (between first quarter and full), with a clear sky (0% cloud cover). The temperature at recording stations 50 and 125 m away was 21.1° C (70° F) with 84% RH. No artificial light was present at the site. The white coloration of the inflorescences is significant, since white blossoms are more visible at night than flowers of other colors. Flowers

pollinated by nocturnal insects are generally white (Faegri & van der Pijl 1971, *The Principles of Pollination Ecology*, 2nd ed., Pergamon Press). Monarchs have been reported previously at artificial light in Texas, Missouri and Mexico (Kendall & Glick, *op. cit.*; Heitzman 1965, *J. Lepid. Soc.* 19: 179-180). Lack of previous reports of nocturnal activity for monarchs in a natural setting indicates that such activity is not normal (Urquhart 1960, *The Monarch Butterfly*, U. Toronto Press).

Several environmental factors may have resulted in the behavior cited in the present note. Drought conditions from late 1970 to mid-1971, followed by heavy rains in early August 1971 resulted in massive numbers of butterflies in late August and September. Although plant growth, including blossom production, was greatly enhanced, little rain occurred from mid-August through September. Flower production was retarded. Feeding pressure from local butterflies as well as the immigrant monarchs resulted in a nectar shortage. The daylight hours of 29 October 1971 were overcast with fog persisting until late morning and cloudiness (80%) as late as mid-afternoon. Only 32% (3.6 hr) of possible sunshine was recorded that day. Conditions for nectar foraging were definitely inferior. As a result, at least one individual fed at flowers at night. The time (pre- or post-sunset) of arrival of the butterfly at the inflorescence is unknown.

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CRAB SPIDER PREYS ON *NEOPHASIA MENAPIA* (PIERIDAE)

On 22 August 1974, an immature crab spider, *Misumenops* sp. (Araneae: Thomisidae), was observed feeding on an adult male pine butterfly, *Neophasia menapia* (Felder & Felder) (Pieridae). The spider and butterfly prey were on a flower of goldenrod, *Solidago rigida* L., in ponderosa pine forest at Sheridan Lake (TIS, R5E, sec. 13), el. 1,400 m, Black Hills National Forest, Pennington Co., South Dakota. Examination of other goldenrods failed to yield additional spiders with butterfly prey, although another *N. menapia* cadaver was found.

Even den (1926, *J. Agr. Res.* 33: 339-344) described the life history of *N. menapia*. Additional information on habits, parasites, and predators of this pierid are given by Orr (1954, USDA, For. Serv., Intermountain For. and Range Exp. Stn., Misc. Publ. No. 1, 12 p.), Cole (1956, USDA, For. Serv., Intermountain For. and Range Exp. Stn., Res. Note No. 29, 8 p.; 1971, USDA, For. Serv., For. Pest Leaflet 66, 3 p.), and Bousfield & Dewey (1972, USDA, For. Serv., Northern Region Insect and Disease Rept. No. I-72-12, 9 p.). Natural enemies include various hymenopterous and dipterous parasitoids that attack the larval and pupal stages, and pentatomids and snakeflies which prey on the eggs. We found no previous records of spiders preying on any of the life stages of the pine butterfly.

The spider feeding on *N. menapia* was captured alive, but an attempt to rear it to maturity failed. Since species determinations of spiders are based chiefly on characters of the genitalia, which are not fully developed until maturity, the specific identity of the spider is unknown although we suspect that it is *M. asperatus* (Hentz), a common inhabitant of goldenrod. A related misumenid crab spider, *Misumenoides formosipes* (Walckenaer), was also found on goldenrod, but without prey. This latter species is readily distinguished from *Misumenops* by the presence of a white clypeal carina. Records of South Dakota crab spiders are given by Buckman (1966, *Proc. S. D. Acad. Sci.* 45: 118-123) and include both *Misumenops asperatus* and *Misumenoides aleatorius* (Hentz) (= *formosipes* (Walckenaer)).

Crab spiders of the subfamily Misumeninae are ambushers and are commonly found on flowering plants, such as goldenrod, where they lie in wait for visiting insects. Some species blend with the background plant color and are capable of

changing from white to yellow or vice versa. Gertsch (1939, Bull. Amer. Mus. Nat. Hist. 76: 277-442) reports that the misumenids have a powerful venom and are capable of quickly subduing insects, including bumblebees, moths, and butterflies, that are much larger than the spiders.

An interesting spider-plant-butterfly relationship is indicated by this collection. Gertsch (1939, Bull. Amer. Mus. Nat. Hist. 76: 277-442) maintains that the habitat of a spider determines the kind of prey that becomes available to it. Flower-inhabiting spiders feed on insects attracted to flowers for nectar, pollen, or other food sources. Although larvae of *N. menapia* are destructive defoliators of pine, Orr (1954, USDA, For. Serv., Intermountain For. and Range Exp. Stn., Misc. Publ. No. 1, 12 p.) reports that the adults feed only on flowers. This habit renders them vulnerable to predation by flower-inhabiting predators, such as crab spiders.

Spider and butterfly are deposited in the collection of the American Museum of Natural History, New York.

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BUTTERFLIES ASSOCIATED WITH AN ARMY ANT SWARM RAID IN HONDURAS

The swarm raids of the army ant *Eciton burchelli* (Westwood) (Formicidae: Dorylinae) are a striking feature of tropical forests throughout Central and South America. Associated with these raiding swarms of *Eciton* are various animals that exploit the swarm raid for the purposes of feeding or reproduction. For example, ant birds (Formicariidae) forage at the leading edge of such swarms and feed on insects flushed from the vegetation by the army ant juggernaut. Flying above the swarm raid are various species of tachinid flies (Diptera: Tachinidae) and other insects, e.g., staphylinid beetles (Coleoptera: Staphylinidae), the life cycles of which may be regularly intermeshed with those of the ants (Akre & Rettenmeyer 1966, J. Kansas Entomol. Soc. 39: 745-782). Some of these flies, for instance, are known to hover above the swarm, then dart down and quickly lay an egg on a prey item being carried back to the army ant bivouac. The egg then develops among the doryline brood (Schneirla 1971, Army Ants, Freeman & Co., San Francisco).

During the early afternoon of 24 May 1972, I observed a large swarm raid of *E. burchelli* in tropical broadleaf forest located on the west shore of Lago Yojoa, Santa Barbara Province, Honduras. Flying low over the leading edge of the swarm were six butterflies: two male *Graphium philolaus* (Boisduval) (Papilionidae: Papilioninae), two female *Mechanitis isthmia isthmia* Bates, and two female *Mechanitis polymnia doryssus* Bates (Nymphalidae: Ithomiinae). These three species were the most common of the several butterfly species in the area, but only the six individuals listed above were flying in the vicinity of the swarm during the observation period. Flying in general ca. 2 ft. above the ground and occasionally dipping down to ground level (but without alighting), the butterflies stayed above the leading edge of the swarm as it moved steadily southward some 20 ft. during the 2 hr that I was able to watch it. The behavior of all three species during this time was similar, although *G. philolaus* had a more soaring and wide-ranging flight than the two ithomiines and, as a result, seemed to be tracking the movements of the ant swarm less closely. Ant birds foraged at the

head of the swarm, but none of the three or four birds present were ever seen to take or attempt to take any of the six butterflies.

Eciton burchelli has a distinctive odor that can be recognized by a sensitive human nose as an army ant odor (Carl W. Rettenmeyer, pers. comm.) and has been described in the old literature (Rettenmeyer, *op. cit.*) as similar to the odor of human feces. Although Dr. Rettenmeyer thinks this description incorrect, the odor is at least unpleasant. This distinctive odor is probably enhanced by the large swarm size and may thereby attract certain animals (Rettenmeyer 1961, Univ. Kansas Sci. Bull. 42: 993-1066). Indeed, the tachinid flies and other insects mentioned above may even respond to the odor as an olfactory signal that initiates oviposition behavior. Perhaps the odor contains elements similar to those of the androconial tufts of *Mechanitis* males, which might explain why only female *Mechanitis* were following the swarm. Longstaff (1912, Butterfly-hunting in Many Lands, Longmans & Co., London) recorded that some clearwing ithomiines in Venezuela had scents of a "disagreeable character, recalling stables or pig-sties," that he believed to be associated with the hindwing androconial brushes (found only in males). However, this does not explain why the male *Graphium* followed the swarm, since in *Graphium*, like the ithomiines, it is the males that have the scent scales. Possibly the *Graphium* males were attracted by a component of the ant odor that elicited food searching behavior.

During 14 months of field research in the tropical rain forests of Eastern Ecuador in 1973-1974, I observed dozens of swarm raids by several colonies of *E. burchelli* in areas rich in ithomiines (but not in *Graphium*) yet never saw any butterflies that seemed in any way attracted to or associated with the army ant swarms. Dr. Rettenmeyer informs me that in his many years of field work on army ants he has never observed any butterflies which appeared to be associated with swarm raids. Thus, it appears that my observation may be unique and, therefore, interesting only as a curiosity, at least until such time as the chemical components of the pheromones of *E. burchelli* are better known.

Specimens of the Honduran army ant population are in the collection of C. W. Rettenmeyer. All six of the observed butterflies are in the personal collection of the author.

ACKNOWLEDGMENTS

These observations were made while I was a student in the Organization for Tropical Studies course 72-2. I thank: C. W. Rettenmeyer for identifying the army ant and for discussion and T. C. Emmel for reviewing the manuscript.

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OBITUARY

ROBERT GRANT WIND (1912–1975)



Fig. 1. Robert and Clo Wind. Photograph taken in 1936.

Robert Grant Wind was born in San Francisco, California, 17 June 1912, the first son of Walter W. Wind and Helen Ables Wind. His father was owner of the Berkeley Plumbing Company, which has been continued as a family business by his brother Howard. Bob, as he was known to his associates, was raised in the community of Berkeley. His family occupied a large house on Santa Clara Street. The basement, attic, and Bob's bedroom provided the storage space needed for his large butterfly and insect collection with its many glass-topped drawers, used Simmons mattress boxes (providing storage for row on row of filed butterflies in envelopes), and 5 gallon metal storage containers (probably containing exotic specimens). At times his bedroom was filled with recently emerged saturniid moths.

Following his graduation from Berkeley High School, he attended the University of California, Berkeley from 1930–1933. In the summer of 1933 he was a Nature Counselor at the Boy Scouts of America Camp Wolfeboro in the Sierra Nevada of Stanislaus County. It was there that Davies and his lifelong colleague William A. Hammer first met Bob. He gave them information on the desirable butterflies of the area and provided their first cyanide bottles for collecting.

In 1933 Bob began the business—Pacific Coast Biological Company—for sales of all types of biological supplies. He also issued extensive lists of world butterflies, moths, and beetles that were offered for sale. He had the use of a large red touring car, and this provided transportation for his entomological friends to field collect or to attend meetings of the Pacific Coast Entomological Society in San Francisco. These included R. M. and G. E. Bohart, R. L. Usinger, J. W. MacSwain,

Art and Edgar Smith, and others. Some also served as his agents collecting specimens to fill orders, or handling orders for his company (Art and Edgar Smith serving the San Joaquin Valley area).

In 1937 Bob married Clo Mifflin of Piedmont. In the following year he sold his business in order to finance and organize the "Papuan-Australian Expedition." It had been his lifetime ambition to explore these areas for their entomological treasures, and, so, in 1938 Bob and Clo left for Sydney, at that time a four week sea voyage. From Sydney they travelled by narrow-gauge railway to Redlynch in North Queensland, in the Cairns area, renting a house from August–December 1938. This permitted the collecting and rearing of the Cairns Birdwing (*Ornithoptera priamus euphorion* (Gray)) and other butterflies, and it was a very pleasant period in their journey. In January 1939, collections were made on Thursday and the Prince of Wales Islands in the Torres Straits. A chartered fishing boat then brought them to Merauke on the mainland of New Guinea where they collected during the months of February and March. They proceeded to the Aru Islands in April where Clo stayed with an Australian family while Bob went on to Fakfak to collect. There he became ill with dengue and he returned to Aru. Bob and Clo then proceeded to the northern part of New Guinea to the village of Babo, in a low marshy area with several rivers, where there was a Dutch oil field. They were permitted the use of houseboats for housing. They journeyed up the Wasian River to Camp 5 at the village of Wasian, and also up the Aimau River by outrigger to Soedoe Point, staying in native huts. Clo became ill with dengue at the latter locality. On her recovery they proceeded to the lowland area of Inanwatan. Bob had contemplated a trip to Bougainville in the Solomon Islands, but due to the late arrival of funds from a supporting institution the trip was cancelled. Meanwhile he had contacted a European collector in Kieta who supplied extensive materials from that area. Leaving New Guinea they travelled west to Ceram, staying for some time at Amboina. From Amboina they proceeded north to Batjan, which they considered a beautiful area. There they enjoyed the generous hospitality of the Dutch inhabitants. Collecting during December was excellent, providing an abundance of specimens of *Ornithoptera priamus croesus* (Wallace). The islands of Obi, Ternate and Halmahera were visited. At the latter Bob became ill with yellow jaundice and an oxcart had to be hired to return him to the boat for Ternate. The Winds decided to visit the Minahasa Peninsula, staying at Tondano in the mountainous northern Celebes so that Bob could regain his health in a more favorable climate. This area is only 1° north of the equator. At nearby Lake Dono (Lake of Man) remarkable collections were made including a very large lycaenid. They left the Dutch East Indies for Manila in 1940 under blackout conditions, as the Second World War had started in Europe. Some collections were made about Manila prior to their return to California.

The Winds returned to Berkeley and Bob undertook lecture tours showing movies of their Papuan-Australian Expedition. Their son Robert M. was born in 1943. The health of both Bob and Clo had been so impaired by their travels that they required hospitalization at the Del Valle Sanatorium in Livermore in 1942 for tuberculosis. Bob conducted a successful philatelic business from the sanatorium. Davies recalls a visit when Bob was sitting in bed surrounded by boxes of stamps and catalogs relative to this mail-order business. During his convalescence he resided in Livermore. He purchased a house there, continuing the philatelic as well as the entomological sales. Davies also recalls the visits made to make butterfly purchases from the extensive Wind expedition materials. At this time Bob's health, even though he had lost the use of one lung, improved sufficiently that he could again start field work.

Davies and Bob collected frequently in the Los Mochos Canyon area, Mitchell's Canyon in Contra Costa County, twice at Strawberry Lake at Pinecrest where the new *Melitaea leanira daviesi* Wind was collected, and at Sonora Pass. Sub-

sequently in the early 1950's they made trips to collect at Partington Canyon in Monterey County. It was in August, 1948 that Arnaud, while camping at Pinecrest and collecting in terrain at the far end of Strawberry Lake, first met Bob, who was collecting butterflies.

It was in the period of 1945-1947 that Bob actively published, as the bibliography shows, on the Indo-Australian Lycaenidae (authored with Harry K. Clench), as well as on North American Satyridae and Nymphalidae. Eighteen species and subspecies were described in 5 papers.

From 1950-1955 the Winds operated the Butterfly Tree Park Museum and Gift Shop in Pacific Grove. This was associated with a motel and a grove of Monterey Pines frequented by the monarch in its winter stay. There were extensive displays of tropical butterflies, beetles, and other "Oh My" insects. A 12 page pamphlet, "Wandering Wings, The Story of Pacific Grove's World-Famous Butterfly Trees" was written and published by Bob at this time.

Starting in 1952 and in following years Bob was interested in magic and was an active member of the Monterey Bay Sahareen (Sorcerers) Club. In 1953 the Winds established their own business—the Funny Abalone—on Fisherman's Wharf in Monterey. Here they sold shells, gifts and butterfly novelties. This successful venture led to the Winds becoming wholesale distributors of natural history materials, particularly shells. To have room for all the stocks required a large facility, and this led to their renting a large warehouse on Cannery Row in Monterey and the establishment of Bob Wind's Butterfly Shop, with floor space of over 20,000 sq. ft. Extensive stocks of insect specimens were handled from all world areas. In 1955 the Winds opened another gift shop—the Trade Winds—also on the wharf at Monterey.

Robert Wind became well-known in his field of business, and this led to awards and articles in newspapers and to TV coverage. He was asked to participate on Art Baker's nationally televised show "You Asked For It" on 5 January 1958, with a portion of the program showing the operation of his Butterfly Shop on Cannery Row. Articles also appeared by John Keefauver on "Butterfly collector settles down with a shop in Monterey" in the Monterey Peninsula Herald, 15 November 1957, and by Lonnie Wilson on "Butterflies on Cannery Row" in the Sunday Parade section of the Oakland Tribune on 2 March 1958. The 12 August 1958 Monterey Peninsula Herald reported that Bob Wind was awarded a gold certificate by the Craft, Model, and Hobby Industry Magazine for "outstanding product developments aiding the growth and welfare of the hobby industry." This certificate was for his butterfly collecting and mounting kits.

In May 1959, in a partnership, Bob opened the restaurant "The Outrigger" located at 700 Cannery Row on the ocean end of the Old Monterey Cannery overhanging the waters of Monterey Bay. The front end of the Cannery was occupied by his wholesale and retail Butterfly Shop, while the restaurant was capable of seating 600 persons (with a 400 person banquet room) with dining on 2 levels overlooking the bay. In October 1960, the Winds opened the much larger Trade Winds Gift Shop in the Carmel Plaza area. The financing of the restaurant business necessitated the gradual sale of the gift shops. In 1965 a business change was required and Bob decided to renew his activities from his own collecting of butterflies and insects from areas in Mexico. He established himself first at Ajijic in Jalisco on Lake Chapala, and later in the state of Chiapas. In 1975 he was moving the site of his collecting from the higher altitudes of Chiapas to new areas of Guatemala. He arrived in Antigua to recuperate his health and to begin collecting there. There were volcanic eruptions in the area at the time, and with his weakened health complicated by respiratory problems, he died on July 4th at Antigua. He was buried there.

Bob will be missed by his many professional and amateur entomological friends throughout the world. He is survived by his widow Clo Wind (now Mrs. Morrie

J. Carroll), his son Robert Mifflin Wind, a brother Howard Wind and two sisters—Mrs. Ray Hetman and Mrs. Marge Harville. We would like to thank Mrs. Carroll for providing data and verifying other information included in this article.

Specimens that Bob collected personally or handled in his dealership are distributed in many major institutional collections and in countless numbers of private collections throughout the world. For materials deposited in the California Academy of Sciences collections, we have the record that between 16 April 1941 and 21 June 1960, in nine transactions (exchanges, gifts, and purchases) the Academy acquired about 9600 insect specimens from localities in Madagascar, New Guinea, Australia, Celebes, and Peru.

His collection of primarily western North American butterflies assembled in the 1930's and 40's, through arrangements made by Davies with Mrs. Clo Carroll and with a donation from Mr. Donald Patterson, was transferred to the Department of Entomology on 1 February 1976. It numbers 3841 pinned specimens. Among the many species represented are the type series of *Megisto rubricata smithorum* Wind (holotype, allotype and 5 paratypes; now assigned CAS Ent. type no. 12575), *Minois meadii melania* Wind (holotype, allotype and 5 paratypes; now assigned CAS Ent. type no. 12576), and *Neonympha henshawi texana* Wind (holotype and 3 paratypes; now assigned CAS Ent. type no. 12574), 6 paratypes of *Coenonympha inornata nipisiquit* McDunnough, 1 paratype of *Incisalia niphon clarki* Freeman, 2 paratypes of *Megathymus evansi* Freeman (now in *Agathymus*), 5 paratypes of *Melitaea leanira daviesi* Wind (now in *Thessalia*), 2 paratypes of *Plebeius scudderii empetri* Freeman (now *Lycaeides argyrognomon empetri*), 2 paratypes of *Speyeria cybele pugetensis* Chermock & Frechin, 1 specimen of the aberration *Nymphalis antiopa hygiaea* (Heydenreich), 14 specimens of the extinct *Glaucopsyche xerces* (Boisduval) and its forms from San Francisco, and 8 specimens of the rare or possibly extinct *Speyeria adiaspe atossa* (Edwards) from the Tehachapi Mountains. Each specimen of this collection is receiving a label indicating that it formed part of the Robert G. Wind collection and was accessioned by the California Academy of Sciences in 1976.

Some Taxa Named After R. G. Wind

- windi* Clench, *Incisalia doudoroffi*, 1943, Can. Ent. 75: 173. New subspecies, holotype female from Placer County, California and three paratypes from Gold Lake, Plumas County; Mt. Elwell; and "Sier. Nev. Cal." Now considered a subspecies of *Incisalia fotis* (Strecker).
- windi* Gunder, *Euphydryas anicia*, 1932, Can. Ent. 64: 283. New race, holotype male, allotype female, and four paratypes collected at Timber Island, Teton County, Wyoming. Now considered a subspecies of *Euphydryas anicia* (Doubleday).
- windi* Gunder, *Plebeius maricopa*, 1933, Can. Ent. 65: 173. New transitional form, holotype male from Berkeley, California. Now considered an aberration of *Plebeius pardalis pardalis* (Behr).

New Taxa—Lepidoptera—Described by R. G. Wind

The collection data are given only for the holotypes.

Lycaenidae

- arfakiana* Wind & Clench, *Callictitia cyara*, new subspecies; 1947, Psyche 54: 60–61. Holotype, male, "Mt. Siwi, Arfak, Dutch New Guinea, 800 meters, May 4, 1928 (Dr. E. Mayr)."
- ariadne* Wind & Clench, *Philiris*, new species; 1947, Bull. Brooklyn Ent. Soc. 42: 7–8. Holotype, male, "Wau, Morobe District, New Guinea, May 6, 1932 (H. Stevens)."

- azula* Wind & Clench, *Philiris*, new species; 1947, Bull. Brooklyn Ent. Soc. 42: 8-9. Holotype, male, "Wau, Morobe District, New Guinea, Oct. 15, 1932 (H. Stevens)."
- bicolorata* Wind & Clench, *Philiris fulgens*, new subspecies; 1947, Bull. Brooklyn Ent. Soc. 42: 9-10. Holotype, male, "Dobo, Aru Islands, June 3, 1939 (R. G. Wind)."
- birou* Wind & Clench, *Philiris intensa*, new subspecies; 1947, Bull. Brooklyn Ent. Soc. 42: 10-11. Holotype, male, "Wau, Morobe District, New Guinea, Aug. 8, 1932 (H. Stevens)."
- deliciosa* Wind & Clench, *Thaumaina uranotauma*, new subspecies; 1945, Pan-Pacific Ent. 21: 14-16. Holotype, male, "Wau, Morobe District, New Guinea, January 30, 1933 (H. Stevens)."
- evinculis* Wind & Clench, *Philiris innotatus*, new subspecies; 1947, Bull. Brooklyn Ent. Soc. 42: 11-12. Holotype, male, "Redlynch, North Queensland, Australia, August 14, 1938 (R. G. Wind)."
- kunupiensis* Wind & Clench, *Candalides meeki*, new subspecies; 1947, Bull. Brooklyn Ent. Soc. 42: 3-4. Holotype, male, "Mt. Kunupi, Menoo Valley, Weyland Mts., Dutch New Guinea, 6000 ft., Nov.-Dec. 1920 (C., F., and J. Pratt), ex coll. E. I. Huntington, Acc. 34,909."
- mayri* Wind & Clench, *Philiris*, new species; 1947, Bull. Brooklyn Ent. Soc. 42: 14-15. Holotype, male, "Mt. Siwi, Arfak Mts., Dutch New Guinea, 800 m., April-June 1928 (Dr. E. Mayr), Acc. 31075."
- misimensis* Wind & Clench, *Philiris*, new species; 1947, Bull. Brooklyn Ent. Soc. 42: 15-16. Holotype, male, "Mt. Misim, Morobe District, New Guinea, 5-6000 feet (H. Stevens)" [date of collection omitted].
- morobe* Wind & Clench, *Candalides grandissima*, new subspecies; 1947, Bull. Brooklyn Ent. Soc. 42: 4-6. Holotype, male, "Wau, Morobe District, New Guinea, April 18, 1932 (H. Stevens)."
- papuanus* Wind & Clench, *Philiris diana*, new subspecies; 1947, Bull. Brooklyn Ent. Soc. 42: 6. Holotype, male, "Wau, Morobe District, New Guinea, June 2, 1932 (H. Stevens)."
- putih* Wind & Clench, *Philiris moira*, new subspecies; 1947, Bull. Brooklyn Ent. Soc. 42: 12-13. Holotype, male, "Pt. Moresby, British New Guinea, April 26, 1939 (R. G. Wind)."
- stevensi* Wind & Clench, *Candalides erinus*, new subspecies; 1947, Bull. Brooklyn Ent. Soc. 42: 1-2. Holotype, male, "Wau, Morobe District, New Guinea, April 4, 1932 (H. Stevens)."

Nymphalidae

- daviesi* Wind, *Melitaea leanira*, new subspecies; 1947, Pan-Pacific Ent. 23: 171. Holotype, male, "Strawberry Lake, Tuolumne County, California, el. 5500 ft., June 26, 1945."

Satyridae

- melania* Wind, *Minois meadii*, new subspecies; 1946, Pan-Pacific Ent. 22: 25-26. Holotype, male, "Marfa Alpine, Texas, July 17, 1941" (Arthur & Edgar Smith).
- smithorum* Wind, *Megisto rubricata*, new subspecies; 1946, Pan-Pacific Ent. 22: 26. Holotype, male, "Marfa Alpine, Texas, July 17, 1941" (Arthur & Edgar Smith).
- texana* Wind, *Neonympha henshawi*, new subspecies; 1946, Pan-Pacific Ent. 22: 27. Holotype, male, "Marfa Alpine, Texas, July 17, 1941" (Arthur & Edgar Smith).

Bibliography of Papers by R. G. Wind with New Taxa

- WIND, R. G. & H. K. CLENCH. 1945. Notes on the genus *Thaumaina* (Lepidoptera: Lycaenidae). Pan-Pacific Ent. 21: 14-16. (One new subspecies.)

- WIND, R. G. 1946. Some new species of North American Satyridae (Lepidoptera). Pan-Pacific Ent. 22: 25-27. (Three new subspecies.)
- WIND, R. G. 1947. A new subspecies of *Melitaea* (Lepidoptera). Pan-Pacific Ent. 23: 171. (One new subspecies.)
- WIND, R. G. & H. K. CLENCH. 1947. New Indo-Australian Lycaenidae (Lepidoptera). Bull. Brooklyn Ent. Soc. 42: 1-16. (Four new species; eight new subspecies.)
- WIND, R. G. & H. K. CLENCH. 1947. The genus *Callicita* (Lepidoptera, Lycaenidae). Psyche 54: 57-61. (One new subspecies.)

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BOOK REVIEW

HISTORY OF ENTOMOLOGY, Editors: R. F. Smith, T. E. Mittler and C. N. Smith. 1973, Annual Reviews, Palo Alto, Calif. 517 p., 42 figs. Price \$10.00 (U.S.).

Lepidopterists should enjoy browsing through this multi-chaptered (20), multi-authored (25) tome, because it covers such a wide span of interesting entomological observations and research. Many of the topics (systematics, paleoentomology, anatomy and morphology, physiology, behavior, etc.) are applicable as background thinking for and appreciation of problems related to moths and butterflies.

A further point of interest, the agreed intent of the editorial committee (Preface) was that emphasis be placed on the personalities of those who have contributed to entomology. Such was ably accomplished in most chapters (many "greats" figured, personal viewpoints and traits noted—even current members of The Lepidopterists' Society, e.g., C. P. Alexander, cited).

Specifically for the Lepidoptera, Lindroth (section 6) devotes several pages to systematists; the soul (psyche) was named from the moth, "phalaene" (p. 38); butterflies were light-trapped in ancient times (p. 52); court trials of destructive caterpillars took place in the 15th century (p. 81); and so forth. Silkworms are discussed in several chapters—that by Yokayama is most instructive for students of lepidopteran biology.

Overall, this History of Entomology is a fine book for all interested in the development and developers of the scientific study of insects.

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——— 1961a. Some contributions to population genetics resulting from the study of the Lepidoptera. Adv. Genet. 10: 165–216.

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Memoirs of the Lepidopterists' Society, No. 1 (Feb. 1964) A SYNONYMIC LIST OF THE NEARCTIC RHOPALOCERA

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

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PRESIDENTIAL ADDRESS 1976—WHAT INSECTS CAN WE IDENTIFY?

RONALD W. HODGES

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I work for an organization, the Systematic Entomology Laboratory of the U.S. Department of Agriculture, which is vitally concerned with recognition and differentiation of insect species. Although the numbers fluctuate from year to year, the 28 scientists in the laboratory identify approximately 250–300 thousand specimens each year. I realize that many of you must wonder as you hear me give these figures why is it that when you send specimens to be identified we do not respond immediately to a request for identification. Much of the very large number of specimens with which we deal comes from agricultural sources such as the plant quarantine stations of Animal and Plant Health Inspection Service, the Agricultural Research Service, the Forest Service, state agencies, international ports of entry, and museums. Our major resources for making these identifications are the National Collection of Insects (approximately 24 million specimens), the combined libraries of the Smithsonian Institution, the Library of Congress, and the National Agricultural Library, and the numerous files of host plants, catalogues, cards, and separates built up by the scientists working with the collection over the last 90 years.

When we talk or think about numbers of insects, we usually refer to the large number of undescribed species. The general estimate is that about 1 million names have been proposed for insects to date and that there may be 1–10 million species to be described. These figures are impressive by any standard and are often cited as one of the major problems in making identifications. But, what about the names in the

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TABLE 1. Percent of specimens associable with described species by museum workers for a series of faunas.

	N. America		Palearctic		Neotropical		Exotic	
	%	Described Species	%	Described Species	%	Described Species	%	Described Species
Diptera								
Culicidae	95	250					50	3500
Mycetophilidae	5	612					8	
Cecidomyiidae	5	1200					1	
Ceratopogonidae	75	400					25	4000
Tipulidae	95	1500					80	14000
Syrphidae	40	1000					25	6000
Muscidae	90	622					40	
Sarcophagidae	95	327					60	
Calliphoridae	95	78					65	
Tachinidae	82	1281			28	2864		
Coleoptera								
Curculionidae	75	2600	50-60		0-5		0-5	
Scarabaeidae	90	1400	90	500	50	2000	5-10	
Coccinellidae	99	400	95	200	50	600	25	
Bruchidae	100	100			90		40-50	900
Buprestidae	80	660					25	11400
Colydiidae	95	110					25	1375
Dermestidae	95	130					40	877
Histeridae	50	360					5	3500
Heteroptera	75		60		50		25-50	
Homoptera								
Aphidae	60	1500					45-50	2000
Aleyrodidae	90	500						
Coccoidea	80	1500	80+	1500	20	1000	40-50	2000+
Cicadellidae (♂♂)	80	3500					12	20000
Hymenoptera								
Symphyta	75	1000	60	2500	25	1000	40	2500
Formicidae								
workers	80	650	30	2000	15	2700	10	3000
♀♀	15		5		1		1	
♂♂	10		5		1		1	
Ichneumonidae	50	2850					15	15000
Chalcidoidea	50-60		50-60				5-15	
Braconidae	65	2000					10	10000
Isoptera								
soldiers	90	45			15	1000	15	1500
alates	90				15		15	
workers	5				5		1	
Lepidoptera								
Lycaenidae	95	300	98+		70		80-85	
Noctuoidea	50	3100					30	50000
Geometridae	90	1200+			50		10-15	10000
Gelechiidae	80	750					10-15	4000

literature? What do they mean as far as an identification is concerned? When you peruse the McDunnough check list or parts of the *Lepidopterorum Catalogus*, what do the names mean to you or to anyone? The answer is that they represent various states of knowledge. In some rare instances the names can be associated with biological entities in contemporary terms. A higher percentage can be associated with morphotypes and identified as such. A yet larger percentage of the names represent nearly nothing to an individual trying to make identifications.

When a field worker in ecology or biological control, or someone making an environmental impact statement, wants to have specimens determined, he normally sends them to one place, usually where systematists are willing or obligated to make determinations. In the United States the Systematic Entomology Laboratory is a major source of determinations on a broad level. In Canada scientists of the Biosystematics Research Institute make determinations. And, there are several regional identification centers such as the California Department of Agriculture, the Florida Department of Agriculture, the Illinois Natural History Survey, the New York State Science Survey, as well as individual systematists at numerous universities.

Because I have access to information about the National Collection and workers associated with it, I asked the following question of our scientists: On the basis of the collection and the literature available to you, what percent of the names in the literature can you associate with specimens for a series of faunas with a fair degree of certainty? The answers were couched with various degrees of uncertainty and were not for a consistent series of zoogeographic areas. For North America north of Mexico I have listed data for each family group. For areas other than this I have data for different associations of areas. Some of the responses are as follows (Table 1):

The numbers become monotonous, but they serve to emphasize the point that we can identify relatively well the described North American fauna and very poorly the fauna from other parts of the world. Also, these figures are for adults. When the comparison is made for taxa for which larvae are known, the contrast is striking (Table 2).

What do these figures mean in practical terms? Currently, we cannot identify with certainty a relatively large percentage of the described world fauna.

Without question there is a need to know what these insects are. When an insect is intercepted at a port of entry, the question arises, "Is it of economic importance or potentially of economic importance?" If it is, certain measures will be taken. If it is not, and the only way

TABLE 2. Percent comparison of larval and adult specimens associable with described species.

	N. America		Palearctic		Neotropical		Exotic	
	%	Described Species	%	Described Species	%	Described Species	%	Described Species
Symphyla								
adults	75	1000	60	2500	25	1000	40	2500
immatures	10		10		1		1	
Formicidae								
workers	80	650	30	2000	15	2700	10	3000
immatures	1		0		0		0	

one can say that it is not is to know what it is, then the commodity can enter the country directly.

A generic or family level determination is not adequate for sampling work. Much of the time and money spent on numerous surveys has been and continues to be wasted for lack of specific determinations. Meaningful comparisons for most purposes can be made only at the specific level. The main reason for stopping short of this level is lack of available expertise and/or cost of determinations. Use of parasitic insects as biological control agents requires specific determinations. The pendulum is swinging back insofar as needing to know exactly what an insect is for control programs in agriculture. No longer can all insecticides be used indiscriminately for pests. Each target insect must be identified on the label, and the insecticide must be used where needed—not ubiquitously. The Systematic Entomology Laboratory was started when there was a need to know insects for agricultural purposes. With the advent of DDT and successors, many entomologists thought that all the crop problems caused by insects would be solved by their use. We know better now. Control or suppression—not eradication—is a major goal in agricultural research today.

Unfortunately, for economic and social reasons, it apparently is not justifiable to spend a research career on basic taxonomic work in most educational institutions. I strongly argue this concept. As long as there is a need to know what animals are, then we must continue the process of making known what has been described, refining our means of recognizing species, genera, and higher categories, and integrating the undescribed species into a system.

Within the Lepidoptera the families are in varying stages of knowledge. The butterflies are probably the best known with the papilionids

at the top of the list. For the large superfamilies, Noctuoidea, Geometroidea, Pyraloidea, Tortricoidea, Gelechioidea, Yponomeutoidea, and Tineoidea, many problems are extant in determining what a name represents or with which genus a new species should be associated. In many instances specimens in collections have been identified by comparison with colored illustrations, by direct visual comparison of specimens with the holotype, by comparison of specimens with other determined specimens (often at the British Museum (Natural History)), by comparison with written descriptions, and rarely by direct comparison with the holotype of several character systems. Most of the major papers written before 1940 have been done without examination of type-specimens, including some that appear useful such as Heinrich's revision of the North American Olethreutidae, or without study of the male and female genitalia. With much of the literature nearly worthless except to validate scientific names and with many specimens in the collection questionably determined, I contend that the base of our science is very weak.

Someone must accumulate a large amount of material for each group in need of revision, draw together the available names (sometimes names are "hiding" in other families or superfamilies), study the type-specimen for each name, and associate each name with one or more specimens in the accumulated material. For a group as large as the Noctuidae with more than 5,300 generic names and 60,000 specific names the initial stages require an immense amount of time and dedication. Variation among specimens must be assessed. To my knowledge species vary in nearly all characters, and for this reason the male or female genitalia sometimes are no more final for specific determination than the shading of the color pattern, wing length, or other characters. Also, reliance on single characters for specific or generic distinction undoubtedly produces untenable classifications. Many of the species and particularly many of the genera are more widely distributed than our predecessors recognized, and often names proposed for specimens from other zoogeographic regions will prove to be senior synonyms of names proposed for specimens from North America. Conversely, many names have been applied too broadly in the past. These factors indicate that the studies should be done on as broad a base as possible, particularly at the generic level. Also, working with large numbers of species and genera gives the student a better perspective for his treatment of all categories.

Special problems that Lepidoptera give to workers are their relatively large size, obvious color pattern, and scale covering. These have enabled many to work without recourse to study of other characters. Or, for wing venation, specimens have not been properly prepared for study.

Many wings have been studied by temporary clearing of a part of the wing with volatile solvents rather than removing the wing, clearing, staining, and mounting it on a slide so that all veins could be studied properly. Many workers didn't use microscopes. Edward Meyrick, who described more than 15,000 species of Lepidoptera, refused to use a microscope until his later years, and he refused to acknowledge that genital characters were worthwhile. He based much of his classification on the venation as seen through a hand lens. Meyrick died in 1938. If Lepidoptera were smaller, then workers would have been forced to study them at greater magnification initially and perhaps done a better job of comparative work.

Lepidoptera, in general are very poorly collected. Although there are series of butterflies from several localities, this is not the case for the moths. There are many instances in which only the holotype is known or the extant specimens are less than 5. Before we can understand the species and their relationships, we must have much better representation of each species from numerous localities throughout its geographic range. This part of the cycle is going to be very difficult to fill because one of the major sources of material is amateur collectors who find it very unrewarding to collect specimens and not be able to identify them. At the moment systematists cannot provide names for many species, or the number of systematists relative to those who would like to have names for specimens is so small that were they to do nothing but name specimens they would have no time for revisionary study.

As we progress in our knowledge of the Lepidoptera, it will become necessary for those who want or need names for specimens to submit them properly prepared, with wings spread, in as good condition as possible, and with the genitalia prepared for study. It is not reasonable to expect the systematist to spend 1-2 hours preparing a specimen, so that he can begin to make a determination unless the correspondent wants to spend \$30-40 for an identified specimen.

One can ask, "Where do we go from here?" At the present rate of study the answer is "not very far." With the current small number of systematists doing revisionary work, the likelihood that the world fauna will be known in a comprehensive manner is very low. The described, world fauna of Lepidoptera is more than 140,000 species, and if projections are correct, the total may be as high as 280,000-1,400,000 species for the world. The demands on systematists' time are such that to be able to revise 60-100 species within a year often is not possible. Also, the first needs are for general studies covering the higher categories through the generic level for the world. If done for smaller zoogeographic

areas, the revisions must take into account the genera of the world. From this point others can revise genera or groups of genera for the world or smaller areas. We also need general manuals for use by a broad spectrum of persons from the amateur to specialist. However, under current administrative requisites for job evaluation large projects are not favored. Many, short publications are preferred over few substantial ones. Unless these attitudes change, I do not see how we can accomplish the work that needs doing. At the same time I feel that a broad audience should be made aware of the poor foundation of systematic entomology.

CONCERNING THE NAME *ANTHOCARIS COLORADENSIS*
HY. EDWARDS WITH DESIGNATION OF A NEW SUBSPECIES
(PIERIDAE)

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Rocky Mountain populations of *Euchloe ausonides* Lucas found east of the continental divide have long been given the subspecies designation *coloradensis*. During a study of speciation in butterflies of the Black Hills of South Dakota and coniferous forest relicts on the western Great Plains, the original description and type specimens of *coloradensis* were found to lend considerable ambiguity to that name. Edwards' (1881) original description of *coloradensis* emphasized dorsal characters of the wing which are generally useless when large series of Rocky Mountain material are considered. Likewise, the two syntype specimens labelled "Colorado" by Edwards and now in the American Museum of Natural History type collection were the only Rocky Mountain representatives in Edwards' hands at the time of the description. Further, one of them represents a minority morph when the larger view of Rocky Mountain *E. ausonides* is considered.

Thus, in describing a new subspecies from conifer forest relicts on the western Great Plains, I am first rediagnosing the name *coloradensis*, based on eastern Rocky Mountain populations in Colorado and Wyoming (Opler, 1968).

Euchloe ausonides coloradensis (Hy. Edwards)

Anthocaris coloradensis Hy. Edwards, 1881, p. 50.

Anthocharis (sic) *ausonides*: Cary, 1901, p. 310.

Anthocharis (sic) *ausonides* var. *coloradensis*: Beutenmüller, 1892, p. 168; 1898, p. 241.

Synchlœ ausonides coloradensis: Dyar, "1902" 1903, p. 7.

Euchloe ausonides coloradensis: Barnes & McDunnough, 1917, p. 3. Barnes & Benjamin, 1926, p. 7. Klots, 1930, p. 154. Leussler, 1938, p. 76. Defoliart, 1956, p. 98. Brown, Eff, and Rotger, 1957, p. 181. Puckering & Post, 1960, p. 8. dos Passos, 1964, p. 49. Opler, 1968, p. 69. Shields, Emmel, & Breedlove, 1969 (1970), p. 31. Ferris, 1971, p. 15. Johnson, 1972 (1973), p. 28.

Euchloe belia var. *belioides* race *montana* Verity, "1905-1911," p. 339.

Euchloe ausonides montana: Barnes & McDunnough, 1917, p. 3 (placed as synonym of *coloradensis*).

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Diagnosis. Distinguishable from *E. a. ausonides* Lucas and the following subspecies by a combination of traits: Under surface, hindwings: (1) green patch between veins RS and M_1 usually isolated on both wings, sometimes only on one; located more caudadistally toward marginal green patch between veins M_1 and M_2 , *not* usually joined to more basad markings as on new subspecies. (2) White patches along inner angle generally invaded by white ground color, *not* recognizable as six alternating large and small smoothly edged patches as on new subspecies. (3) Green marbling less invaded by white ground color than on *ausonides*, more than on new subspecies. Under surface, forewings: (4) black crescent, distal end discal cell, at largest touching both veins R_2 and M_3 . Upper surface, forewings: (5) apical area, black patterning darker than *ausonides* and new subspecies.

Male. Upper surface of the wings: white; forewings, dark apical-subapical markings; discal cell, distal end, black crescent. Hindwings darker in areas where "marbling" occurs on under surface.

Under surface of the wings: white; forewings, olivaceous apical-subapical markings; discal cell, distal end, black crescent. Hindwings white with green "marbling" incised by white ground color; distal green patch between veins M_1 and M_2 usually isolated, white surrounding it.

Length of forewing: 20 mm (male type).

Female. Wing characters identical with male.

Length of forewing: 21 mm (female type).

Male genitalia (Fig. 2). Tegumen flattened dorsally; uncus long, gradually tapered, often exceeding posterior end of valvae; valvae, apex directly slanted anteriorly toward dorsal articulation, anterior margin slightly concave, aedeagus, phallobase, noticeable "two-step" structure.

Female genitalia (Fig. 2F). Not useful for infraspecific diagnosis.

Early stages. Not specifically studied in relation to nominate *E. ausonides*, see Opler, "1974" (1975).

Food plant. In Colorado, *Arabis*, *Descurainia* (Cruciferae) (Shields, Emmel, & Breedlove "1969" (1970)); *Arabis*, *Sisymbrium*, *Erysimum* (Cruciferae) (Remington (1952)).

Types. In the American Museum of Natural History collection (AMNH): type, male, "Colorado"; type, female, "Colorado." In his description of *coloradensis*, Edwards implies that he possessed only two specimens at the time of his description but knew of, or had seen, others. The collection of the American Museum of Natural History contains two specimens labelled by Hy. Edwards as male type and female type. Because the female type does not accurately represent the *coloradensis* morph I hereby designate the male type as the lectotype.

Distribution. By present diagnosis and material examined: Rocky Mountains of Colorado and Wyoming east of the continental divide. Varying somewhat westward in Colorado and blending into *a. ausonides* in western Wyoming (Ferris, 1971; Opler, 1968).

Flight period. Early June–September (in Colorado (Brown, Eff, & Rotger, 1957)).

Remarks. 126 specimens were submitted to character analysis (see Discussion). 20 male and 10 female genitalia were examined.

***Euchloe ausonides palaeoreios* Johnson new subspecies** (Figs. 1 & 2A, D)

Anthocharis ausonides: Cary, 1901, p. 310.

Euchloe ausonides ausonides: Puckering & Post, 1960, p. 8.

Euchloe ausonides coloradensis: Leussler, 1938, p. 76. Johnson, 1972 (1973), p. 28.

Diagnosis. This subspecies can be differentiated from *E. a. coloradensis* by a combination of traits: Under surface, hindwings: (1) green patch between veins RS and M_1 usually heavily joined with median green patch between veins M_1 and

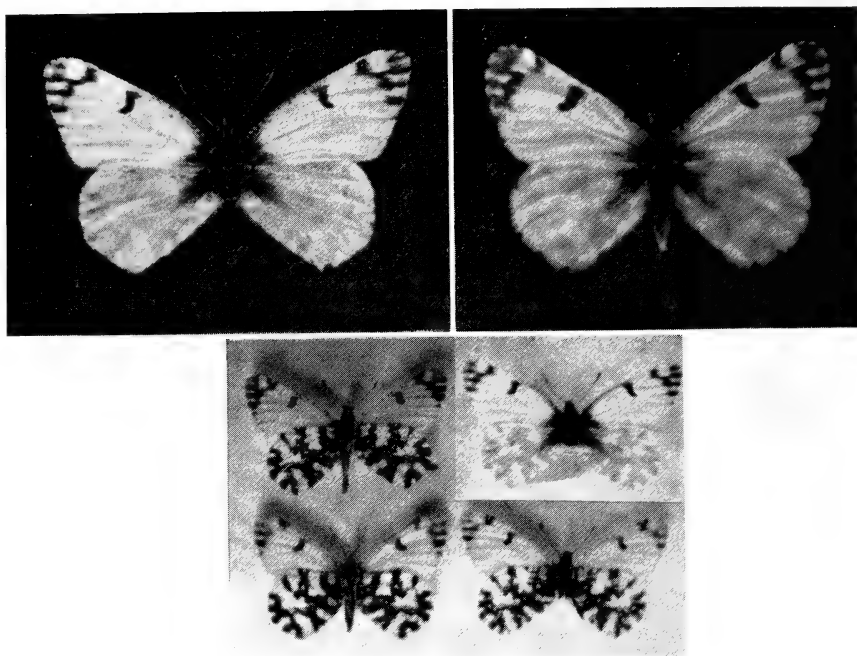


Fig. 1. *E. a. palaeoreios*, n. subsp. Top upper left: upper surface of the wings, holotype, male. Top upper right: upper surface of the wings, allotype, female. Bottom, center (variation in under surface of the wings): top left, under surface of the wings, paratype male, Black Hills near Sundance, Wyoming; top right, same, upper surface of the wings; bottom left, under surface of the wings, allotype, female; bottom right, under surface of the wings, holotype, male.

M_2 (along cell) on one, or more often both wings and located more cephalobasad on the wing. (2) White patches along inner angle most often appear as six smoothly edged patches alternating large and small. (3) Edges of green marbling quite entire and noticeably smooth. Under surface, forewings: (4) black crescent, apical end, discal cell, nearly always broadly edging veins R_2 and M_3 with black, sometimes extending to vein CU_1 . Upper surface, forewings: (5) apical area black patterning lighter and less extensive.

Male. Upper surface of the wings: white; forewings, dark apical-subapical markings; discal cell, distal end, expansive black crescent. Hindwings darker in areas where "marbling" occurs on undersurface.

Under surface of the wings: white; forewings, olivaceous apical-subapical markings; discal cell, distal end, expansive black crescent. Hindwings white with green marbling little invaded by white ground color, distal green patch between veins M_1 and M_2 usually joined cephalobasad with green patch between M_1 and M_2 .

Length of forewing: 20 mm (holotype); 15 mm–22 mm (\bar{x} = 19 mm), paratype males.

Female. Wing characters identical with male.

Length of forewing: 18 mm (allotype); 21 mm–23 mm (\bar{x} = 22 mm), paratype females.

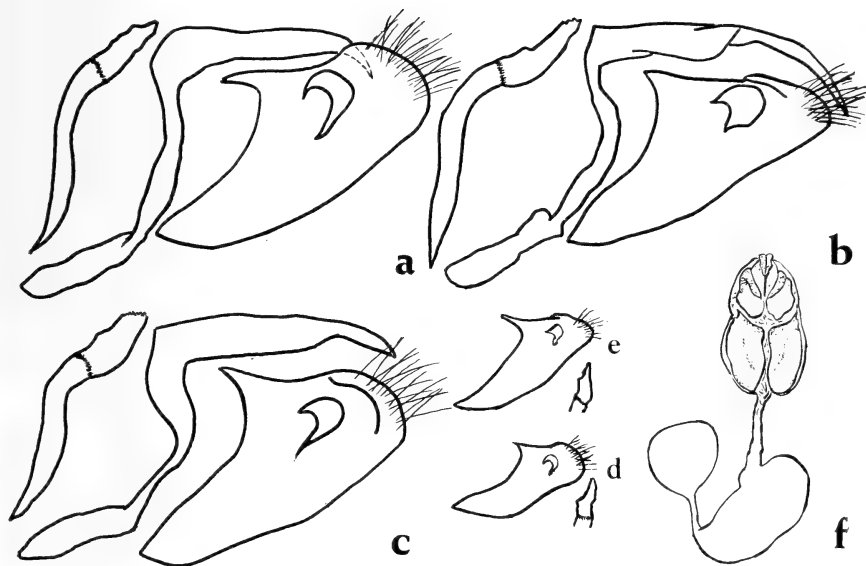


Fig. 2. (A) Genitalia, *E. a. palaeoreios*, n. subsp., holotype (AMNH), lateral view, aedeagus removed. (B) Male genitalia, *E. a. coloradensis*, Hy. Edwards "Colorado" (AMNH, K-27), lateral view, aedeagus removed. (C) Male genitalia, *E. a. ausonides* (Boisduval), Oakland, California (AMNH, K-3), lateral view, aedeagus removed. (D) Valva, lateral view, *E. a. palaeoreios*, Sundance, Wyoming (AMNH, KJ #171b). (E) Same, *E. a. coloradensis*, Laramie, Wyoming (AMNH, KJ #23). (F) Female genitalia, *E. a. ausonides*.

Male genitalia (Fig. 2A, D). Tegumen somewhat humped, rounded dorsally; uncus, apex more toothed than tapered; valvae, anterior margin deeply concave, apex broad, not immediately slanted toward dorsal articulation; aedeagus, phallobase, roughly tapered.

Female genitalia. As typical of the species (Fig. 2F). Not useful for infraspecific diagnosis.

Early stages and foodplant. Not specifically known.

Types. Holotype, male, Spearfish Canyon, near Spearfish, Lawrence Co., South Dakota, 26 June 1939 (AMNH). The genitalia are in vial K. Johnson #4. Holotype and genitalia are in the collection of the American Museum of Natural History. Allotype, female, Spearfish Canyon, nr. Spearfish, Lawrence Co., South Dakota, 26 June 1939 (AMNH). Genitalia are in vial K. Johnson #6. Deposited as above. Paratypes (all Lawrence Co., South Dakota): American Museum of Natural History, males: 3 specimens, near Lead, 24 June 1939; 1 specimen, near Lead, 22 June 1939 (all A. C. Frederick); 2 specimens, Spearfish Canyon, 26 June 1939 (collector unknown); 1 specimen, Spearfish Canyon, 1 July (year unknown) (collector unknown); 1 specimen, Ice Box Canyon, 28 June 1939 (A. C. Frederick). Females: 1 specimen, Custer State Park, 1 July 1962 (F. H. Rindge). Los Angeles County Museum, male: 1 specimen, near Lead, 24 June 1939 (A. C. Frederick); female: 1 specimen, near Lead, 24 June 1939 (A. C. Frederick). Allyn Museum of Entomol-

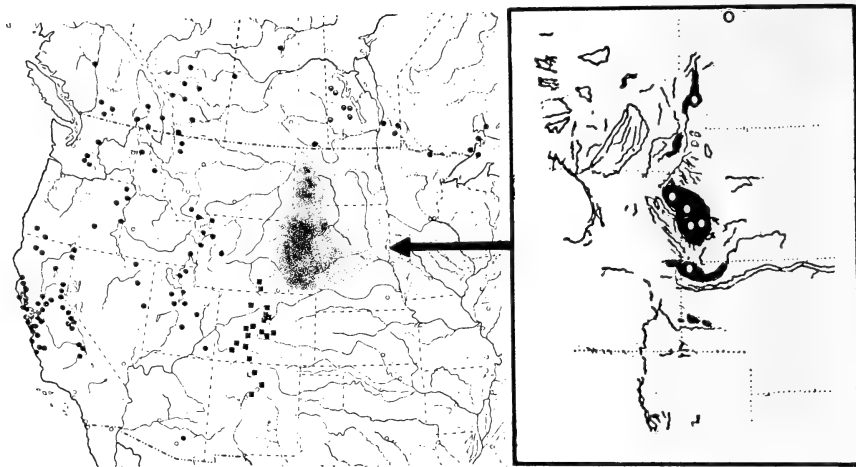


Fig. 3. Distributional and post-Pleistocene relationships of *Euchloe ausonides* subsp. Left: Distributions of *E. a. ausonides* (circles), *E. a. coloradensis* (squares), and *E. a. mayii* (half-open circles) in continental United States and southern Canada. Eastward, in United States, pepper-dotted configuration shows probable maximum extent of post-Pleistocene conifer forest on the present-day western Great Plains: darkly blackened areas—upland climax conifer forest, lightly dotted areas—pine-juniper open woodland. Right: Inset of area on western Great Plains, showing western North Dakota, South Dakota, and Nebraska, plus Colorado, Wyoming, and Montana. Blackened areas show present montane conifer forests surviving on the Great Plains; black lines show present distribution of scarp woodlands in same region. Known localities of *E. a. palaeoreios* are indicated by white dots. Left of figure adapted from Opler (1968) by permission.

ogy, male: 1 specimen, Terry Peak, 24 June 1939 (A. C. Frederick); female: 1 specimen, Terry Peak, 24 June 1939 (A. C. Frederick).

Distribution. The Black Hills of South Dakota and Wyoming, the Pine Ridge of Nebraska (not recently recorded), the Little Missouri River escarpments in North Dakota, and possibly the Lone Pine Hills in South Dakota and Montana, and the Killdeer Mountains in North Dakota. One plains population is known, represented by two specimens from Port Roch (sic) [Port Roche], Saskatchewan, deposited in the AMNH.

Flight period. Dates on specimens range from 5 June–8 July.

Remarks. 26 specimens, 7 male and 7 female genitalia were studied from the Black Hills; 6 specimens, 3 male and 3 female genitalia were studied from Saskatchewan; 28, 3, and 3, respectively from Manitoba; 27, 3, and 3 from Alberta; and 5, 1, and 1 from Ontario (all AMNH). Six specimens, 2 male and 2 female genitalia were studied from Nebraska (Canyon Region north of Harrison, Sioux County), obtained from Ohio State University. I have included in the distribution of this entity only those areas where wing characters and genitalia are very near the description, not areas where the phenotype diverges or possibly intergrades with other taxa or unnamed populations.

Etymology. The name is from the Greek words *palaeos* (old) and *oreios* (of the

mountains), meaning "of the old mountains." It refers to the relict montane areas from which this stock evidently originates (Johnson, 1976).

DISCUSSION

Following the retreat of the Wisconsin glacier, vast climax pine forests connected the present-day Pine Ridge and Wildcat Hills of Nebraska, Black Hills of South Dakota, and escarpments of western North Dakota. They also extended eastward along the present Niobrara River and into east-central Nebraska (Johnson, 1976).

These conifer areas had formerly been mixed with prevailing boreal forest at the beginning of the glacial retreat (11–12,600 years ago) but became predominant about 10,000 years ago as the boreal forests were destroyed. Climax pine forests then became centered on the western uplands of these states and connected westward to the Rocky Mountains through moist pine-juniper woodland. Thus, an eastward region of the Rocky Mountain environment was present at that time. However, a gradual trend toward aridity eventually cut off these eastern forests from their western allies and eventually from each other, leaving all as sub-climax pine woodlands except the climax-forested Black Hills. This trend was gradual at first, a slow drying and decimation of the moist savannahs lasting perhaps 5–7000 years. However, an arid cycle (supplemented by fire) beginning about 2000 years ago rapidly isolated the present relicts themselves, which have continued to decline.

Because of this, the subspecies *palaeoreios* just described is distinct from Rocky Mountain *E. a. coloradensis* and, similarly, does not bear the relationship to Canadian prairie populations that might be inferred from present-day geography. Thus, the new name *palaeoreios* helps define both *E. a. coloradensis* and the divergent phenotype from the Ridings Mountains of Manitoba represented by the name *E. a. mayii* (Chermock & Chermock).

It has not been my intention to introduce confusion into the identity of Canadian prairie populations by naming *palaeoreios*. I believe the geographic origin of *palaeoreios* is distinct from both *E. a. coloradensis* and Canadian prairie populations which probably have a more northern origin. Thus, I have included Canadian material in its distribution only where the genitalia are almost identical to topotypical dissections. The former climax forests, spoken of above, had widespread pine-juniper savannah extensions, of which the central Nebraska "arm" has been the only one studied by paleobotanists (Johnson, 1976). These former extensions are now plains, but the distinct affinity of their remaining montane butterflies to those in the scattered relict scarp woodlands is clear.

The frequencies of six traits, in 132 specimens from six populations.

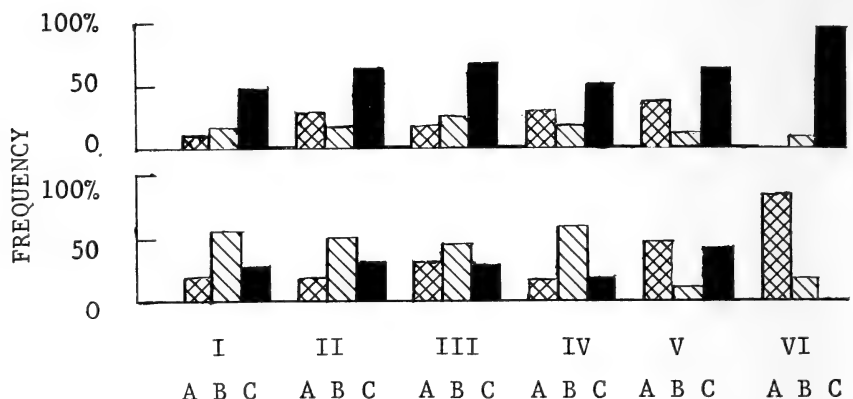


Fig. 4. Frequency distributions of six traits in two major wing characters in *Euchloe a. coloradensis* and *E. a. palaeoreios*. Six populations are analyzed: (I) Rocky Mountain National Park, Colorado ($n = 39$); (II) Gunnison County, Colorado ($n = 14$); (III) Custer County, Colorado ($n = 20$); (IV) Edwards' Type Series ($n = 10$); (V) Laramie, Wyoming ($n = 23$); (VI) Black Hills, South Dakota, Wyoming ($n = 26$). Categories: (bottom) Relationship of patch between RS and M_1 with that median between M_1 and M_2 —(A) These patches joined on both wings, (B) one wing, (C) neither wing. (top) Relationship of patch between RS and M_1 with that marginal between M_1 and M_2 —(A) These patches joined on both wings, (B) one wing, (C) neither wing.

are compared in Fig. 4. In the new entity, the marked relationship of (1) joining of the patch between RS and M_1 with that median between M_1 and M_2 , and (2) its cephalobasad location away from any joining with the marginal patch between M_1 and M_2 is clear. These frequencies also show how the Edwards female type did not accurately represent the *E. a. coloradensis* morph. This problem has been solved by the designation of a lectotype. The exact number and subsequent location of specimens Edwards knew of at the time of the description are unclear. However, a total of 10 specimens in the American Museum of Natural History Collection bear his handwriting and the label "Colorado." These have been included in the above analysis to place his apparent idea of the name in a more realistic perspective. This, and the rediagnosis, should make the name *coloradensis* much more meaningful for future workers; the new name *palaeoreios* serves to separate *coloradensis* from the distinct scarp woodland and prairie population which has a distinct eastern origin.

ACKNOWLEDGMENTS

I especially want to thank Dr. Frederick H. Rindge (Curator of Lepidoptera the American Museum of Natural History) for his helpful com-

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PHOTOPERIODIC REGULATION OF SEASONAL POLYPHENISM
IN *PHYCIODES THAROS* (NYMPHALIDAE)CHARLES G. OLIVER¹

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The useful but not widely known term "polyphenism" was introduced by Mayr (1963) and refers to any sort of intrapopulation phenotypic variation that is not directly genetic. It thus includes all environmentally regulated variation that is shown in the phenotype. Seasonal polyphenism in Lepidoptera is regulated by environmental factors, and, as I have discussed in a previous paper (Oliver, 1970), may be manifested either as a discontinuous shift in phenotypic appearance or as a continuous shift in the range of phenotypic variation along a gradient. In either case the environment triggers an initial genetic response in the organism which canalizes development toward a "seasonal form."

Seasonal polyphenism in multivoltine populations of *Phyciodes tharos* Drury belongs to the discontinuous type. The wings of summer adults (form "morpheus" Fabricius, Figs. 1, 2) tend to be less intensely colored than those of spring and fall adults (form "marcia" Edwards, Figs. 3, 4). This tendency is more pronounced on the ventral sides of the wings and is most extreme in late winter individuals from the southern part of the range (e.g., Cedar Key, Florida). Table 1 gives a comparison of the phenotypic appearances of the two forms. A great range in color variation is shown in any sample at any location at any time of year. The adaptive significance of a basically similar phenomenon in *Colias* (Pieridae) has been discussed by Watt (1968).

The chief factors responsible for the regulation of seasonal polyphenism in Lepidoptera are photoperiod (Pease, 1962; Shapiro, 1968) or temperature (McLeod, 1968) alone or a synergism between the two (Ae, 1957). Klots (1951) implies that it is exposure to cold in the pupal stage that induces the "marcia" form, but no experimental evidence is presented. The experiments described here were designed to test the response of *P. tharos* to different photoperiod and temperature regimes during the larval and pupal stages.

PROCEDURE AND MATERIALS

Laboratory breeding stock was derived from three wild-inseminated females. One female was collected 4 mi. E Cedar Key, Levy Co., Florida,

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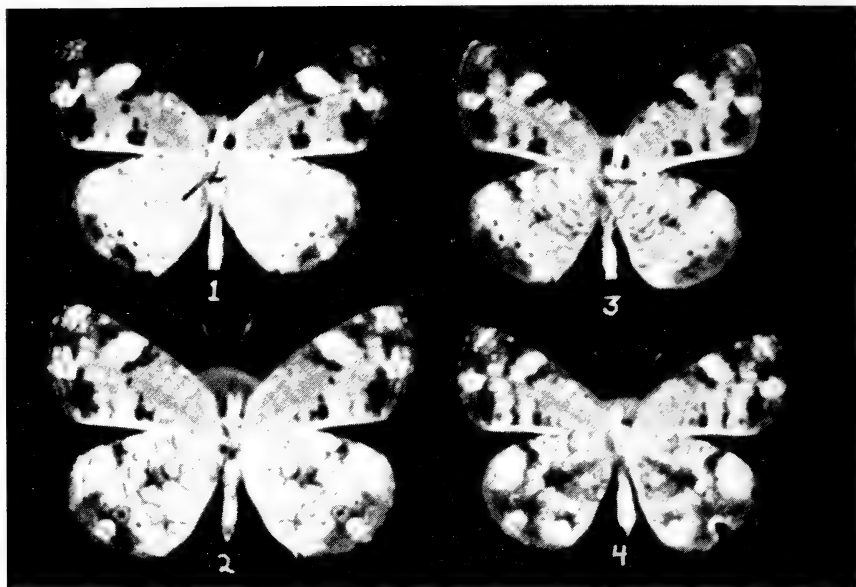
TABLE 1. Comparison of phenotypic appearance of most contrasting specimens of seasonal forms "marcia" and "morpheus" of *Phycodes tharos*.

"marcia"	"morpheus"
Dorsal	
1. Submarginal spots clear, contrastingly pale.	Spots obsolescent, dark gray if present.
2. Marginal and submarginal black lines light and separated.	Black lines fused into a band.
3. Male forewing postmedian black markings well expressed.	Dark markings obsolescent, making an open light area.
Ventral (Hindwing)	
Males	
1. Brown markings heavy, smudgy.	Brown markings thin, crisp.
2. Silver crescent spot bright, blurry.	Crescent covered by submarginal dark patch.
Females	
1. Brown markings heavy, very smudgy, filling areas between light spot bands.	Markings forming a thin, crisp brown reticulation.
2. Basal, median, submarginal light bands suffused with silver-white.	Crescent spot only silver-white present, light bands straw yellow.

29 March 1969, and the others 4 mi. N Emporia, Sussex Co., Virginia, 3 May 1969. Populations from these areas appear similar in phenotypic appearance and are indistinguishable in the laboratory. Potted *Aster ericoides* L. served as the oviposition site and larval foodplant. The newly-hatched larvae in each brood were divided into a long day, short night group (15hL, 9hD) and a short day, long night group (10hL, 14hD). Both groups were given a 25°C day and a 22°C night. When the short day group entered the third instar, it was divided into two lots, one of which was kept on the same temperature regime, and the other of which was given a 25°C day and a 5°C night. These regimes were maintained through the pupal stage and until adult emergence. Cultures were maintained in climate-controlled growth chambers with a temperature fluctuation of less than 2°C during each temperature period. Artificial lighting was provided with fluorescent tubes of the "sunlight" type. Chilling to 5°C was carried out in an unlighted domestic refrigerator.

RESULTS

The adults from the long day, short night group (N = 21) were of the "morpheus" form (Figs. 1, 2), whereas those from the short day, long night group (N = 46) were all of the "marcia" form (Figs. 3, 4).



Figs. 1-4. *Phyciodes tharos*: 1 & 2, form "morpheus" reared on photoperiod regime of 15hL, 9hD; 3 & 4, "marcia" reared on 10hL, 14hD.

No phenotypic differences were observed in the responses of the two population samples. Differences in temperature regime in the short day group had no apparent effect on adult phenotype. These laboratory-reared broods of *P. tharos* showed great phenotypic homogeneity compared to wild-collected samples.

DISCUSSION

Seasonal polyphenism in *Phyciodes tharos* is controlled by photoperiod. The fall and spring "marcia" form is induced by the comparatively short days and long nights of late summer and early spring. Fall "marcia" have apparently developed without larval diapause, whereas spring "marcia" have undergone diapause. "Morpheus" is due to the long days and short nights of early and mid summer.

Phenotypic variation in wild seasonal samples of *P. tharos* may be attributable to differences in larval photoperiod exposure as well as to individual genetic variation. The intensification of the "marcia" appearance in southern U.S.A. samples (where the growing season ends and begins with shorter days and longer nights than in the northern U.S.A.) indicates that the effect is a graded one in nature.

There was no incidence of diapause among the *P. tharos* larvae on either photoperiod regime. Regulation of diapause in this species has not been investigated, but it may be influenced by larval temperature exposure during the first two instars. In any case diapause and polyphenism seem to have no direct link in this species.

SUMMARY

Photoperiod regulates expression of the seasonal forms of *Phyciodes tharos*. A larval and pupal photoperiod regime similar to that of early summer produced adults all of the "morpheus" form, whereas a regime similar to that of late summer produced only "marcia." Larval and pupal temperature exposure had no effect on adult phenotype.

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LARVAL FOODPLANTS AND LIFE HISTORY NOTES FOR EIGHT MOTHS FROM TEXAS AND MEXICO¹

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So far as I can determine, nothing has been published on the life history of the species in the present paper except for *Madoryx oichus* (Cramer). Apparently this species uses the same larval foodplant in Mexico as it does in Venezuela (Lichy, 1944). Blanchard (1973) recorded and illustrated 3 of these species (*Syntomeida melanthus* (Cramer), *Rhescipha servia* Cramer, and *Scordylia atalanta* Guenée) as rare or possibly new to Texas and the United States. Blanchard (1968) also described and illustrated *Grotella margueritaria* from Texas. Munroe (1972, 1973) described and illustrated *Odontivalvia radialis* from Texas. Guenée (1857) described the family Hedyliidae and placed therein *Venodes napiaria* (Brazil), *Phellinodes satellitiata* (Brazil), and *Hedyle heliconiaria* (French Guiana) which he described *ibidem*. It is believed the latter species is here recorded from Mexico for the first time.

Sphingidae

This report confirms the infrequent occurrence of *Sphinx lugens* Walker within the United States and gives its local larval foodplant, *Forestiera pubescens*. Life history notes, including a possible larval foodplant, *Tabebuia pentaphylla*, are given also for the cocoon spinning Mexican *Madoryx oichus* (Cramer). An adult ♀, pupa, and 2 cocoons are illustrated.

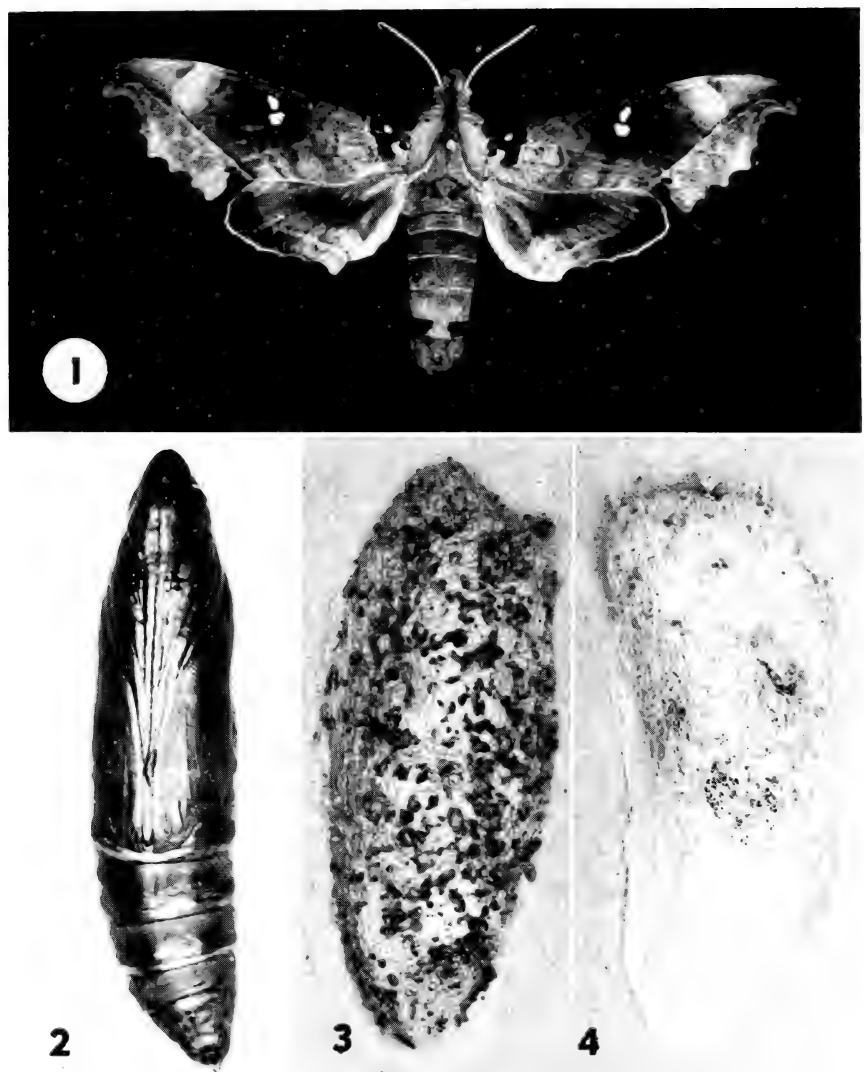
Sphinx lugens Walker 1856. Hodges (1971) indicated that the immature stages of this species were unknown, and that Strecker (1876:115) incorrectly cited *Salvia* as a host when he accepted *eremitoides* as a junior synonym of *lugens*. He states further: "Although I have seen no authentic specimens of *lugens* from the southwestern United States, it is to be expected in southern Arizona and New Mexico or Texas. Some of the earlier literature citations to this species probably refer to other, closely related species."

On 8 August 71 in my lab garden at San Antonio, Texas I found 1 larva feeding on the foliage of a small (60 cm), cutover plant of *Forestiera pubescens* Nutt., OLEACEAE. This larva continued to eat until 12 August when it entered soil which had been provided, and in which it pupated unobserved; a ♀ emerged 28 August 71. This remains the only example found, although I have examined the foodplant frequently for immatures since then. Other species of *Forestiera*, including *F. pubescens*, are found in Mexico, and perhaps may be acceptable to *S. lugens* throughout its range.

Madoryx oichus (Cramer) [1780]. Hodges (1971) in treating the genus *Madoryx*, stated: "The one known larva [imagine not given] is peculiar for a sphingid inas-

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Figs. 1-4. *Madoryx oiclus*: 1, ♀, dorsal view (expanse 93 mm); 2, pupa, ventral view (length 57 mm); 3, cocoon spun on tree trunk (length 85 mm); 4, cocoon spun on whitewashed wall.

much as it resembles that of a species of *Catocala* in the Noctuidae. . . . The pupa is dark and glossy, banded with pale orange at the base of some abdominal segments, and the base of the tongue projects forward somewhat." Lichy (1944) reported *Tecoma pentaphylla* (= *Tabebuia pentaphylla* (L.) Hemsl.), BIGNONIACEAE, as the larval foodplant in Venezuela.

On 15 November 74 at Los Arcos Courts, Ciudad Mante, Tamaulipas, Mexico, I found 1 spun-up larva; it had selected a spot, ca. 60 cm above ground, on the white-washed outside wall of the court where we stayed. This larva pupated 16 November and a ♀ emerged 16 December 74 (Fig. 1). Also, on the same wall about 2 m away from the first, another cocoon was found near the eve, but this one had emerged. A third cocoon, containing a live pupa (Fig. 2) was found 5 December 74 about 10 m from the first 2 and about 2 m above ground on a tree trunk, *Tabebuia pentaphylla*. This tree is planted extensively in Mexico as an ornamental and known locally as "Palo de rosa." Still later, Mrs. Kendall found a fourth empty cocoon spun on the side of a concrete stepping block near the ground. In each instance, the cocoons were found on or within 2 m of *T. pentaphylla*, undoubtedly its larval foodplant.

Most interesting was the larva's ability to camouflage its cocoon to match the background on which it was spun. Note the darkened color and bits of tree bark in the silk of the cocoon spun on the tree (Fig. 3); compare this cocoon with Fig. 4, the one spun on the outside wall, and note its lighter color and bits of whitewash in the silk. The darkened areas of the latter are caused by the empty pupal case inside. I had overlooked 3 of these cocoons several times earlier because the sunlight had not struck them at the proper angle.

Ctenuchidae

Syntomeida melanthus (Cramer) 1779. Near Ciudad Mante, Tamaulipas, Mexico single larvae were collected crawling on the ground as if in search of food on 11 January 74, 26 January 74, and 12 February 74. These larvae proved to be parasitized by dipterons; both host and parasites were preserved. Again on 21 November 74, Mrs. Kendall found a cluster (ca. 40) of first instar larvae feeding on the foliage of *Ipomoea populina* House, CONVULVULACEAE. This plant was fairly well defoliated, and later searching proved other plants to be in the same state of dormancy. Because of the scarcity of food most larvae died of malnutrition. Seven larvae spun cocoons between 21 December 74 and 4 January 75, but only 3 pupated; adults emerged 16 January 75 (♀), 17 January (♂), and 18 January (♀).

In general appearance the larva of this species resembles that of an *Halisidota*. The last instar larva is clothed with short gray pile; there is a lateral row of black tufts; 3 mid-dorsal segments have paired white tufts lightly overlaid with gray hairs; the first 2 and last segment have paired long black hair pencils; head black. Larval hairs form the basis of the cocoon which is generally formed on the long axis of a twig.

Noctuidae

Grotella margueritaria Blanchard 1968. While on a joint field trip with André and May Elise Blanchard, Mrs. Kendall and I were fortunate in discovering 2 larval foodplants for this recently described species. On 17 September 71, ca. 3 km N of Study Butte, Brewster Co., Texas, we collected a few larvae resting on the stems of *Anulocaulis leisolenus* (Torr.) Standley, NYCTAGINACEAE. These larvae were lost because it was not realized at the time that they eat blossom buds, not foliage. At the type locality in Big Bend National Park, 12 more larvae were collected 21 September 71, feeding on the blossom buds of *Anulocaulis eriosolenus* Standley. One parasitized larva produced a dipteran 8 October 71. Seven other larvae burrowed in dirt on 21 and 22 September 71 where they pupated in earthen chambers. Later, when the dirt was screened, 2 pupae were exposed, and they later became parasitized; adult parasites were found 20 August 72. Other pupae, in their sealed earthen chambers, produced adults: 19 October 71 (♂), 22 October (♂), 24 October (♂), 29 October (♀), 24 August 73 (♀), and 6 September 73 (♂). Two larvae and 1 deformed pupa were preserved. It was interesting that 2 remained in pupal diapause for al-

most 2 years. This would indicate that the species is well adapted to Chihuahuan Desert conditions.

Because there is some question as to the proper systematic placement of *Grotella*, a completely illustrated and described life history for *G. margueritaria* will be published as soon as it can be reared from eggs of a known female.

Resciphia servia Cramer 1782. On 13 November 71 at Santa Ana National Wildlife Refuge, Hidalgo Co., Texas, I collected 1 pupa in a leaf nest on *Rivina humilis* L.; a ♂ emerged later the same day. After finding this pupa I had thought *R. humilis* might be the larval foodplant. On 18 June 72, however, I found a larva at my lab in San Antonio, Bexar Co. feeding on the foliage of *Diospyros texana* Scheele, EBENACEAE. A few days later a second larva was collected feeding on the same plant. The first larva spun a cocoon in the leaves of the foodplant 1 July, and a ♂ emerged 15 July 72. The second larva was preserved after passing through 7 instars and at the time it started spinning its cocoon. It is interesting to note that the larva of this species is catocala-like, both in appearance and habits; when not feeding it rests flat along the foodplant branches.

Adults have been taken at my lab doorlight: 25 October 71 (♀), 17 November 71 (♀), 13 June 72 (1♂, 1♀), 1 July 72 (♂), 2 July 72 (2♂), 8 July 72 (♂), 10 July 72 (♂), 7 August 72 (♂), 7 August 73 (♀), 30 October 73 (♂) and 1 July 75 (♀). Based on these dates at least 2 broods are indicated.

Geometridae

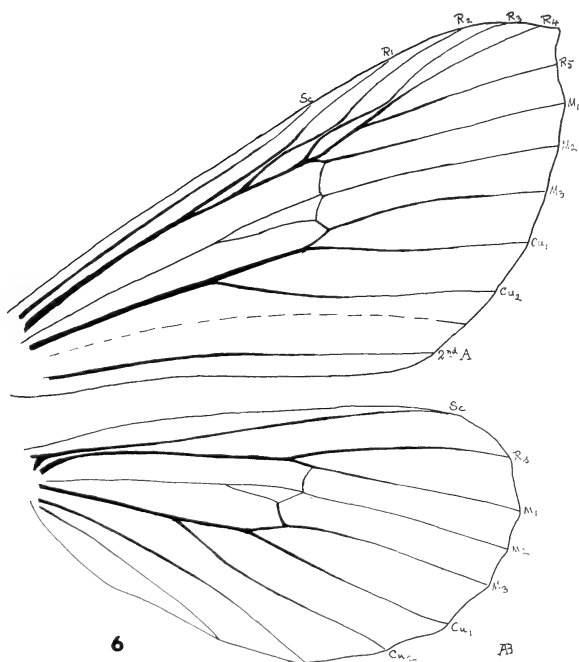
Scordylia atalanta Guenée 1857. On 28 January 75 near Ciudad Mante, Tamaulipas, Mexico, about midafternoon I observed a ♀ ovipositing on the foliage of *Serjania racemosa* Schumacher, SAPINDACEAE. In the field lab this ♀ deposited 14 more eggs the same day, but it became quiescent at sunset. On the following day, 38 more eggs were deposited during daylight hours; that evening, the ♀ was killed and papered. Several eggs were preserved, and the remaining ones started hatching 1 February 75, ca. 2030 hrs. The young larvae were offered foliage of *Urvillea ulmacea* H.B.K., SAPINDACEAE which they readily ate. On 14 February the larvae were offered swelling blossom and leaf buds of *Ungnadia speciosa* Endl., also SAPINDACEAE, which they ate and on which they matured. Fifteen larvae pupated between 21 and 28 February 75; adults emerged (7♂, 5♀) from 3–11 March 75. Twelve eggs, 12 larvae and 3 pupae were preserved.

At the same time the gravid ♀ was collected, 2 larvae were found on a bit of the larval foodplant, *S. racemosa*, gathered at the site and placed with the captive female. These 2 larvae pupated 14 February 75, and 2 ♀ emerged 26 and 27 February 75.

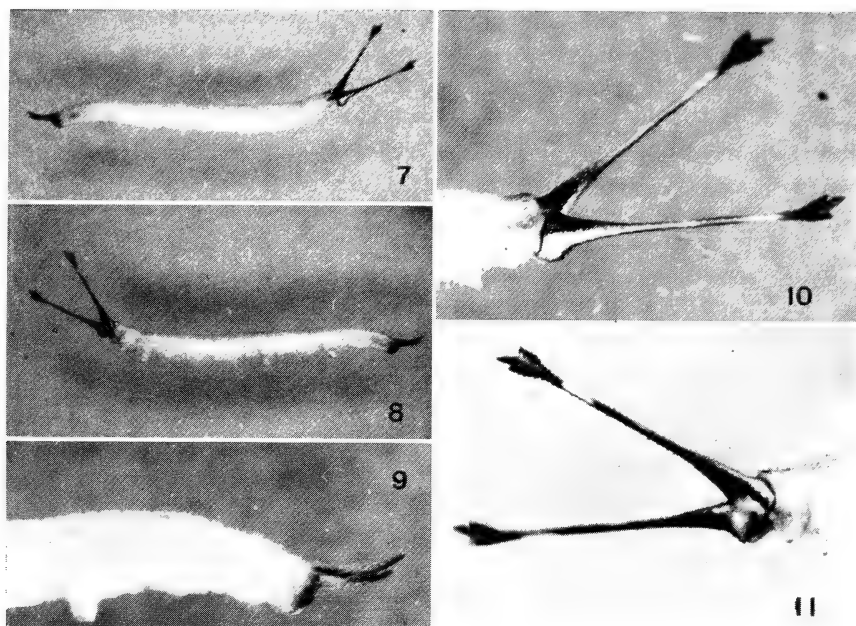
Hedylidae

Hedyle heliconiaria Guenée 1857. Recently I had the good fortune to rear this most interesting species (Figs. 5, 6). Although a few of the diurnal adults were collected earlier, I never associated them with the larvae (Figs. 7–11) collected later. In fact, I thought the larvae might represent a satyr species, but when the first larva pupated I was sure it was a pierid. The first adult emerged as a complete surprise. The pupa (Figs. 12–15) is secured by girdle and cremaster, not unlike a pierid. Several egg shells, presumably of this species, were found deposited singly on top of leaves. Larvae rest on top of the leaves, oriented along the mid-vein, their color and configuration providing excellent camouflage, at least to the human eye. Larval feeding consists of eating, at random, a series of small holes in the leaf on which it rests.

On 6 February 74 at Rancho Pico de Oro, near the Rio Sabinis, Tamaulipas, Mexico, Mrs. Kendall and I collected 13 larvae feeding on the foliage of *Buettneria aculiata*



Figs. 5-6. *Hedyle heliconiaria*: 5, ♀, ex larva 11 March 1974, Ranch Pico de Oro, Tamps., Mexico (expanse 32 mm); 6, wing venation, same specimen.

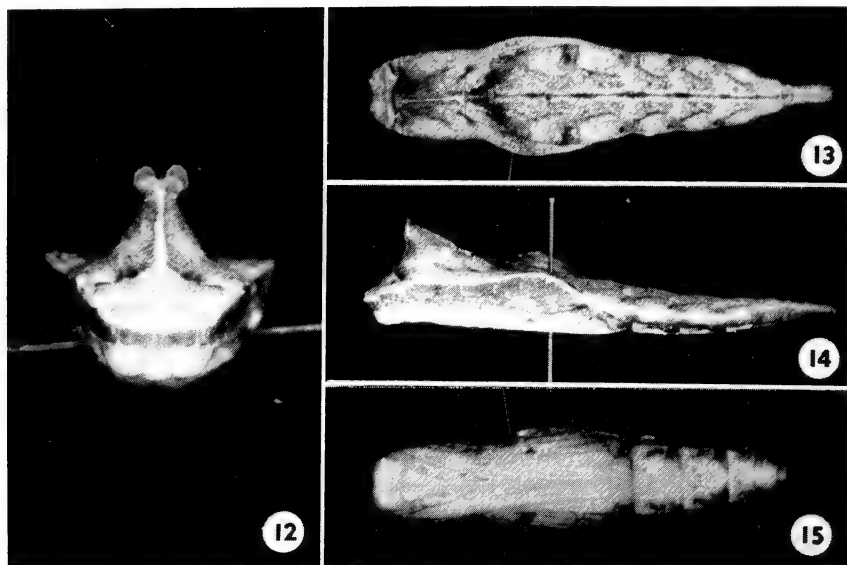


Figs. 7–11. *Hedyle heliconiaria*: 7, last instar larva, dorsolateral view; 8, ventrolateral view; 9, anal end and process; 10, larval head, laterodorsal view; 11, larval head, lateroventral view.

Jacq., STERCULIACEAE. Six of these larvae pupated between 9 and 20 February 74; adults emerged 19 February (♂), 25 February (♀), 2 March (♂), and 11 March 1974 (♀). Seven larvae and 2 pupae, most of which were parasitized, were preserved. Again on 10 November 74, near Ciudad Mante, Tamaulipas, about 12 more (1st and 3rd instar) larvae were collected on *B. aculiata*; 2 of these were preserved the same day. On 17 November it was discovered that all remaining larvae except 2 had been eaten by 3 predatory fly larvae, predators on the foliage which had gone unnoticed at the time of collecting. The 2 remaining larvae pupated 26 November 74; 1 was preserved and the other proved to be parasitized.

Pyalidae

Odontivalvia radialis (Munroe) 1972. On 15 September 71 at Dagger Flat, Big Bend National Park, Brewster Co., Texas, while collecting *Thessalia chinatiensis* (Tinkham) (Nymphalidae) larvae on *Leucophyllum minus* Gray, SCROPHULARIACEAE, I found 3 micro larvae in silken tunnels covered with frass and attached to the branches of this plant. These 3 larvae were taken to the lab in San Antonio where little activity was observed in the rearing container (glass jar with screened lid). The small amount of foodplant brought to the lab soon dried, and because no activity was observed it was not until 8 June 73 that I decided to clean the jar. At this time (some 21 mos. later) I found 1 larva had pupated, 1 was dead, and the third was still in diapause. The pupa and diapausing larva were placed on a moist sponge. The following day a ♂ emerged. On 15 June 73 the larva had not pupated.



Figs. 12-15. *Hedyle heliconiaria*: 12, pupa, frontal view; 13, dorsal view; 14, lateral view; 15, ventral view.

but upon my returning from a field trip 6 July, it had; another ♂ emerged 7 July 73. This is another species well adapted to Chihuahuan Desert conditions.

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A KEY TO THE LAST INSTAR LARVAE OF WEST COAST SATURNIIDAE

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This following key will facilitate the identification of 16 species of saturniid larvae found in California, Oregon, and Washington. The identification of either live or preserved larvae should be possible since morphological characters have been stressed. Observation of many of the characters requires a 10 power hand lens. Secondary emphasis has been placed on color, since those colors derived from plant compounds, such as green and yellow, fade quickly to white or cream in preservatives. Pigments which are black or brown, however, remain rather constant. The first character in each couplet is assumed to be the most important.

In addition to host plant and distributional information for each species, a reference to a paper containing a larval description is included. Other references which would aid in the identification of saturniid larvae include Peterson (1962) and Ferguson (1971, 1972). Ferguson includes keys for the identification of many eastern species, with the Citheroniinae receiving the most complete treatment. Peterson's work provides some information on preservation techniques, as well as a few illustrations of the more common eastern species.

All material examined during the construction of this key was from California populations. The author would appreciate receiving any larva which does not key out correctly. It is unfortunate that at this time a complete key to the western species could not be published, but preserved larvae of a number of species from Arizona and New Mexico are lacking.

KEY TO THE LAST INSTAR LARVAE OF WEST COAST SATURNIIDAE

1. Dorsal thoracic scoli unarmed, consisting of 2 pairs of enlarged, caudally recurved spikelike projections on both meso- and metathorax (Fig. 1a); spikelike median dorsal scolus on abdominal segment VIII; ground color green (Citheroniinae) *Sphingicampa hubbardi* (Dyar) 2
- Dorsal thoracic scoli branched or armed with spines (Figs. 1b, c, d, e, f); median dorsal scolus on abdominal segment VIII present or absent; ground color variable 2
2. Dorsal scoli not branched, but rounded, cylindrical, or bulblike with spines (Figs. 1b, c, d); ground color green or yellow-orange (Saturniinae) 3
- Dorsal scoli branched (Figs. 1e, f); ground color black, gray, brown, or yellow (Hemileucinae) 8

3. Dorsal thoracic scoli bulblike or cylindrical and $1\frac{1}{2}$ –3 times longer than wide; spines on dorsal scoli equal to or less than width of scoli (Figs. 1b, c); ventral scoli of thoracic segments without spines or with 2 spines shorter than length of scoli (*Hyalophora*) 4
 - Dorsal thoracic scoli rounded, length approximately equal to width; spines on dorsal scoli $2\frac{1}{2}$ –8 times longer than width of scoli (Fig. 1d); ventral scoli of thoracic segments with 2 or more spines 2–3 times longer than length of scoli (*Antheraea* & *Saturnia*) 5
4. Dorsal meso- and metathoracic scoli cylindrical with complete black band at midpoint (Fig. 1c); caudal scoli length usually less than width *Hyalophora euryalus* (Boisduval)
 - Dorsal meso- and metathoracic scoli bulblike; band at midpoint incomplete on two or more scoli (Fig. 1b); caudal scoli length greater than width *H. gloveri* (Strecker)
5. Abdominal segment VIII with median dorsal scoli; ventral surface green *Antheraea polyphemus* (Cramer)
 - Abdominal segment VIII not bearing median dorsal scoli; ventral surface light to dark brown (*Saturnia*) 6
6. Two or fewer dark setae on dorsal portion of any proleg; setae not extending past tip of proleg 7
 - Four or more dark setae on dorsal portion of any proleg; setae may extend beyond tip of proleg (Fig. 2a) *Saturnia mendocino* Behrens
7. Lateral bands on abdominal segments extending ventrally from lateral scoli to sublateral scoli and touching the posterior edge of spiracle; some setae on prolegs extending from chalazae (Fig. 2b) *Saturnia albofasciata* (Johnson)
 - Lateral bands absent; setae on prolegs extending from pinaculae rather than chalazae (Fig. 2c) *S. walterorum* Hogue & Johnson
8. Dorsal and lateral scoli with short barrel-like branches, 2 or less times longer than wide (Fig. 1e); lateral ocelli in heavily sclerotized semicircular area *Coloradia pandora lindseyi* Barnes & Benjamin
 - Dorsal scoli in rosettes, lateral scoli with branches 3 or more times longer than wide; sclerotized area surrounding ocelli similar to rest of head capsule (*Hemileuca*) 9
9. Secondary setae not arising from circular white or yellow spots 10
 - Secondary setae arising from circular white or yellow spots giving skin a reticulated appearance 12
10. Clypeus with 6–10 setae; ventral abdominal surface black to brown; prolegs black *Hemileuca nuttalli* (Strecker)
 - Clypeus with 4 setae; ventral abdominal surface white, red, or black; prolegs red or black 11
11. Ventral intersegmental area white or cream colored; prolegs black; body with 3 lateral white bands; median dorsal line incomplete; microscopic cream colored dots ventral to spiracle *Hemileuca hera* (Harris)
 - Ventral intersegmental area red to light brown; prolegs red; 1–3 complete lateral bands (may be absent in coastal populations); median dorsal line absent; no microscopic dots ventral to spiracle *H. eglanterina* (Boisduval)
12. Clypeus with 4 setae; white band covering 30% or less of clypeus 13
 - Clypeus with 6–8 setae; white band covering 40% or more of clypeus 14
13. Branches of sublateral and ventral scoli white; dorsal scoli of rosette type only on abdominal segments I–VI *Hemileuca electra* Wright
 - Branches of sublateral and ventral scoli with basal $\frac{1}{3}$ – $\frac{1}{2}$ dark, tip dark brown; dorsal scoli with branching setae extending from rosettes on all abdominal segments *H. burnsi* Watson
14. Dorsal rosette setae white-yellow with black tip; ground color yellow *Hemileuca nevadensis* Stretch

- Dorsal rosette setae dark brown at base, distal $\frac{1}{3}$ - $\frac{1}{2}$ of setae dark, mid-portion white; ground color gray to brown 15
15. Secondary setae on ventral intersegmental area hyaline brown; prolegs red; proximal $\frac{1}{3}$ - $\frac{1}{2}$ of rosette setae brown *Hemileuca neumoegeni* (Edwards)
- Secondary setae on ventral intersegmental area brown; prolegs brown; proximal $\frac{1}{2}$ of rosette setae black *H. juno* Packard

Distributional and Host Plant Information

Sphingicampa hubbardi. Distribution: California (new state record) 1 ♂, 1 ♀, Bonanza King Mine, Providence Mts., San Bernardino Co., Cal., VIII-20-37; same locality, 1 ♂, VIII-23-37; 1 ♂, Wheaton Springs, at general store, Mescal Range, San Bernardino Co., Cal., elev. 4000', VIII-30-41, C. Henne collector. All 4 specimens are in the collection of Mr. Henne. The specimens from the Providence Mts. were taken by the watchman, name unknown. Habitat: high desert. Host: possibly *Acacia greggii*. Larval description: Comstock (1947).

Hyalophora euryalus. Distribution: general. Habitat: chaparral, oak woodland, and pine forest. Hosts: *Ceanothus*, *Salix*, *Rhus*, *Ribes*, *Schinus*, *Arctostaphylos*, *Arbutus*, *Prunus*, and many minor hosts including *Quercus*. Larval description: Packard (1914).

Hyalophora gloveri. Distribution: California, east slope of Sierra Nevada, from Inyo Co. to Alpine Co. and probably farther north. No available records for Washington or Oregon, but it should occur in the extreme eastern portion of each state. Habitat: Great Basin and pine forest. Hosts: *Salix*, *Purshia tridentata*, *Prunus virginiana*, and *Rosa*. This species frequently hybridizes with *H. euryalus* where they are sympatric in California. Larval description: Packard (1914).

Antheraea polyphemus. Distribution: general. Habitat: oak woodland, riparian, and residential. Hosts: *Quercus*, *Salix*, and *Betula*. Larval description: Packard (1914).

Saturnia albofasciata. Distribution: California only, known from Lake and El Dorado counties south to Los Angeles and San Bernardino counties. Habitat: mixed chaparral from 1300-7000'. Host: *Ceanothus cuneatus* and *Cercocarpus betuloides*. Larval description: Hogue et al. (1965).

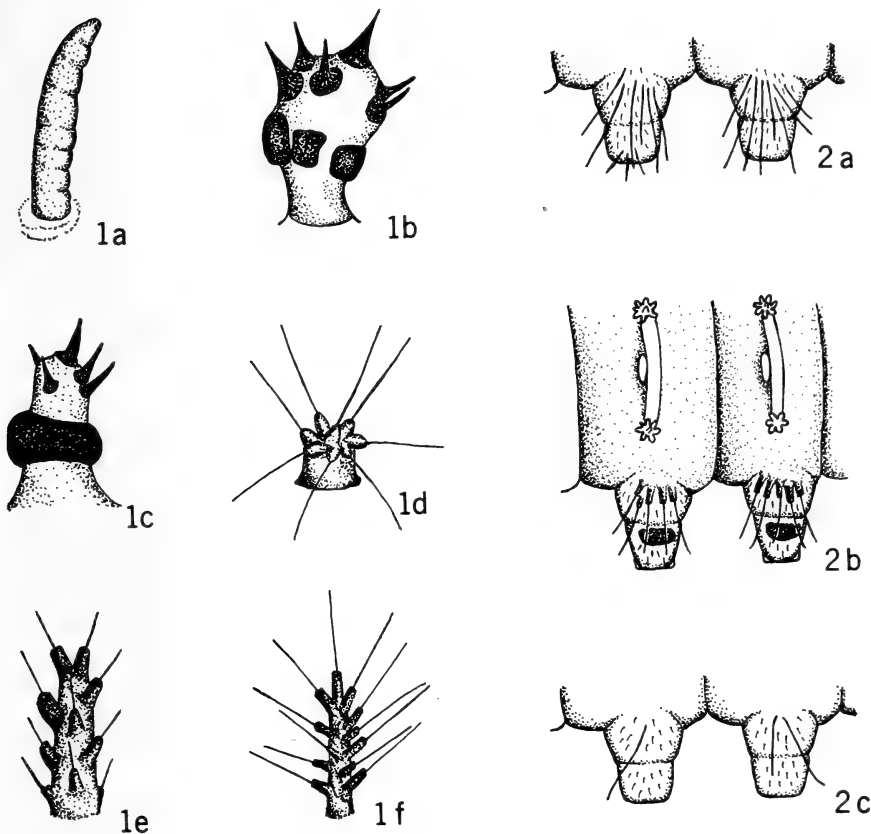
Saturnia mendocino. Distribution: California, Shasta Co. south to Santa Cruz Co., also western slopes of the Sierra Nevada south to at least Mariposa Co. Oregon, one record (Ashland, Jackson Co., IV-14-1946, Coll. Martin). Habitat: chaparral, pine, or mixed oak woodland. Hosts: *Arctostaphylos* and *Arbutus*. Larval description: Comstock (1960).

Saturnia walterorum. Distribution: California only, San Luis Obispo Co. south to San Diego Co. Habitat: chaparral to pine forest, sea level to 6000'. Hosts: *Rhus laurina*, *R. integrifolia*, and *Arctostaphylos*. Larval description: Sala & Hogue (1958).

Coloradia pandora lindseyi. Distribution: southern Oregon and California; spotty over much of its range. Habitat: pine forest. Hosts: *Pinus ponderosa* and *P. jeffreyi*. Larval description: Patterson (1929).

Hemileuca hera. Distribution: California, eastern slopes of Sierra Nevada. Oregon and Washington, eastern half of each state, especially the Columbia River basin. Populations are frequently very localized and scattered. Host: *Artemisia tridentata*. Larval description: McFarland (1964).

Hemileuca eglanterina. Distribution: general. Habitat: varied, riparian in dry areas, to moist oak-pine forests. Hosts: *Salix*, *Ceanothus*, *Purshia*, *Prunus*, and *Symphoricarpos*. Two subspecies occur in California and Oregon: *H. eglanterina shastaensis* (Grote) is known from Shasta, Plumas, Lassen and Siskiyou counties in California, also Klamath and Jackson counties in Oregon. *H. eglanterina annulata*



Figs. 1a-f. Dorsal metathoracic scoli of: 1a, *Sphingicampa hubbardi*; 1b, *Hyalophora gloveri*; 1c, *Hyalophora euryalus*; 1d, *Saturnia mendocino*; 1e, *Coloradia pandora*; 1f, *Hemileuca* sp.

Figs. 2a-2c. Prolegs of abdominal segments III and IV: 2a, *Saturnia mendocino*; 2b, *S. albofasciata*. 2c, *S. walterorum*.

Ferguson is known from the east slope of the Sierra Nevada Mts. from Inyo to Alpine Co. Larval description: Ferguson (1971).

Hemileuca nuttalli. Distribution: eastern Oregon, Washington, and California, similar to that of *H. hera*. Habitat: sagebrush areas. Hosts: *Symphoricarpos* and *Purshia*. Larval description: McFarland (1974).

Hemileuca electra. Distribution: California only, Los Angeles, Riverside, San Bernardino, and San Diego counties. This species may occur slightly farther north along the coast. Habitat: chaparral. Host: *Eriogonum fasciculatum*. *H. electra* clio Barnes & McDunnough occurs in desert areas of the above four counties. Larval description: Comstock & Dammers (1939).

Hemileuca nevadensis. Distribution: spotty over much of California and Oregon. One sight record from southern Washington. Habitat: usually riparian. Hosts: *Salix* and possibly *Populus*. Larval description: Comstock & Dammers (1939).

Hemileuca burnsi. Distribution: California, Los Angeles Co. east, and north along the eastern slope of the Sierra Nevada. Habitat: high desert. Hosts: *Tetradymia*, occasionally *Dalea*, or *Prunus fasciculata*. Larval description: Comstock & Dammers (1937).

Hemileuca juno. Distribution: California, Imperial Co. near Yuma. This species may occur in portions of Riverside and San Bernardino counties. Habitat: desert. Hosts: *Prosopis* and possibly *Cercidium*. Larval description: Comstock & Dammers (1939).

Hemileuca neumoeni. Distribution: California, Providence Mts., San Bernardino Co. Habitat: High desert-chaparral. Hosts: *Rhus trilobata* and *Prunus fasciculata*. Undescribed.

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LOW COST VACUUM FREEZE-DRYING

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The major cost of most vacuum freeze-drying systems is the vacuum pump. By replacing this expensive pump with a water aspirator, the cost of vacuum freeze-drying can be reduced by 90% or more. This will provide a system at a price the average lepidopterist can afford.

An excellent treatment of vacuum freeze-drying was done by Dominick (1972). He includes many theoretical and practical ideas which help in understanding this process. The following paper will deal with my modifications of the vacuum freeze-drying process, and complications which arise from these modifications.

Theory

Although a fine treatment of the theoretical aspects of vacuum freeze-drying was given by Dominick (1972), a review of the theory as it applies to this modified system is presented here.

At a fixed temperature and in a closed container, the vapor pressure caused by the evaporation of water (or ice) will be constant, regardless of the amount of vacuum initially applied (Dalton's Law of Partial Pressures). When a desiccating agent is placed in this container (but not in direct contact with the water or ice), the desiccant absorbs some of the water vapor. This causes more water (or ice) to evaporate in an attempt to maintain the partial pressure which is characteristic for that temperature. This means that the major driving force of dehydration is independent of the initial vacuum in the container. However, even though the driving force is independent of the initial vacuum, a container which is initially evacuated will evaporate a piece of ice faster than one with no vacuum. As Dominick explains it, "the more molecules of other gases present (air), the more difficult it is for the molecules evaporating from the water (or ice) to dissipate; then a state of quasi-saturation will be reached near the water (or ice) surface and further evaporation will cease." Actually, the evaporation will only slow down rather than cease. This means that vacuum freeze-drying can take place at any level of vacuum; however, the lower the pressure the faster the process. Table 1 compares the times necessary to dehydrate an average butterfly larva at different vacuum levels.

A water aspirator will attain a vacuum of around 15 mm Hg. My basic idea was to use this as a source of vacuum, in spite of the longer drying

TABLE 1. Comparative times for dehydrating average butterfly larva.

.001 mm Hg	15 mm Hg	760 mm Hg ¹
2 days	14 days	100 days

¹ Data at 760 mm Hg was obtained by Flaschka & Floyd (1969).

times, in order to reduce the cost of a vacuum source from over \$200 to less than \$15.

Equipment

At this point a physical description of an aspirator vacuum freeze-drying system is in order. The basic components can be seen in Fig. 1. In order to aid in the selection of suitable equipment, each of the four components of the system (aspirator, trap, valve, and desiccator jar) will be discussed.

The aspirator can be one of a number of different models. One of the main differences in aspirators is the vacuum they will produce with a given water pressure. Unfortunately, this data is hard to get from many suppliers. For my work I examined four different models, and chose an aspirator made of glass, by Kimax. It has a free air flow of 6.5 liters/min. with 40 lbs. of water pressure and is rated to pull down a 16 oz. jar to 16 mm Hg. in a maximum time of 1½ minutes. This glass aspirator requires a hose clamp, a hose, and an adapter for a kitchen faucet. These can be purchased from most hardware stores. Other aspirators are easier to connect since they come with threads on the aspirator and can be attached directly to the water faucet.

The next component is the trap. This insures that if something goes wrong (such as a sudden change in the water pressure), water will not back up into the desiccator jar. A vacuum trap is excellent, but a home-made trap is almost as good and is very inexpensive. A good home-made trap consists of a thick-walled jar with a two-hole rubber stopper inserted into it. Two pieces of glass or copper tubing are tightly inserted into the holes. One of the pieces of tubing should almost touch the bottom of the jar, and should be connected to the hose going to the aspirator. The other piece of tubing should only be inserted far enough to barely clear the rubber stopper, and should be connected to the hose going to the desiccator jar. In this way, water backing up will have to nearly fill the trap before it can back up into the desiccator, allowing time to shut off the valve to the desiccator jar. Do not reverse the order of the hose connections to the trap, or its purpose will be defeated.

The third component is the valve. This item is hard to find at a low

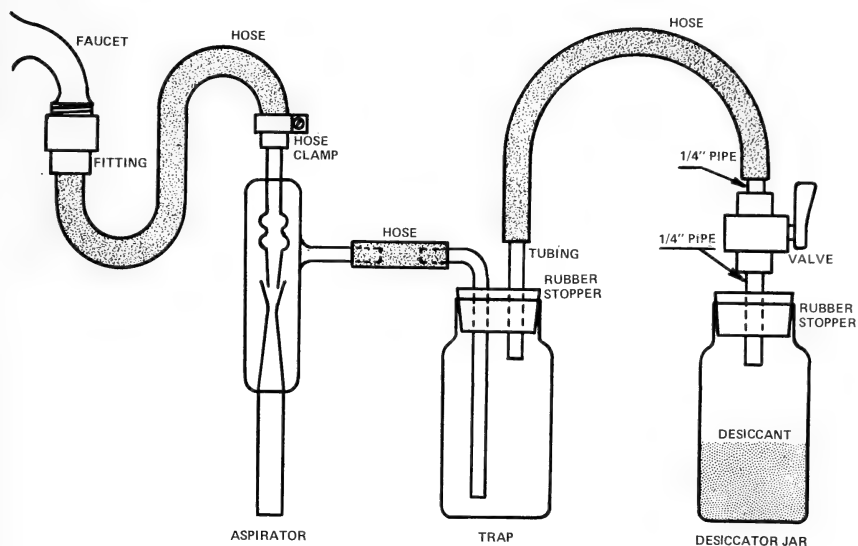


Fig. 1. Diagram of an aspirator vacuum freeze-drying system.

cost. The simplest choice is to buy a stopcock, but current costs for stopcocks are around \$8-\$15 (U.S.) each. Polyethylene one-way valves are inexpensive and in theory should work, but I have had numerous experiments ruined because they failed to operate properly. Several other types were tried with some success, but my best results have been obtained with equipment that can be bought at many hardware stores. Most good hardware stores carry various valves to fit $\frac{1}{4}$ " pipe. Obtain one with two female connections. Also purchase a three inch piece of $\frac{1}{4}$ " pipe. Cut this pipe in half, and attach half to each end of the valve. Bore a $\frac{1}{4}$ " hole through the rubber stopper you are going to use as a desiccator lid. As seen in Fig. 1, the pipe (which is attached to the valve) is inserted through the hole in the stopper. The valve, pipe, and stopper cost about \$2.50.

The last component is the desiccating jar. This jar should be thick-walled and fitted with a one-hole rubber stopper. I use the same type of jar as in the trap. These are thick-walled square 8 oz. bottles with a wide mouth, have a cap size of 43 mm, and take a #7 rubber stopper. One word of caution: before using any jar with a vacuum, test it by wrapping some towels around it and connecting it to the vacuum source. Even jars of the same brand should be checked individually to make sure

TABLE 2. Efficiency of desiccants.

Material	Residual Water per Liter of Air, 30.5°C (in mg)
$\text{CaCl}_2 \cdot \text{H}_2\text{O}$	1.5
$\text{Ba}(\text{ClO}_4)_2$, anhydrous	0.82
NaOH , sticks	0.80
CaCl_2 , anhydrous	0.36
$\text{Mg}(\text{ClO}_4)_2 \cdot 3\text{H}_2\text{O}$	0.03
Silica gel	0.03
KOH , sticks	0.014
Al_2O_3	0.005
CaSO_4 , anhydrous	0.005
CaO	0.003
$\text{Mg}(\text{ClO}_4)_2$, anhydrous	0.002
BaO	0.0007
P_2O_5	lower

they don't implode. Tape can be wrapped around the jar as a further safety measure.

A vacuum hose or a large diameter thick walled hose should be used in connecting the trap to both the aspirator and the desiccator jar. A washing machine hose is excellent for connecting the aspirator to the faucet.

One additional part of the system needs to be discussed. This is the desiccant. I use CaSO_4 which is impregnated with an indicator. The desiccant is blue when it is active, and turns red when it can no longer absorb water. This desiccant can be reactivated by placing it in a shallow dish in an oven set for 450°F. One brand name for this desiccant is Drierite (with indicator). Other desiccants can be used, but CaSO_4 , as seen from Table 2 (Bower, 1934), is one of the most efficient. The last point in this discussion of desiccants is to be sure not to overload the system. The 8 oz. jar should be no more than one third full of desiccant. This should be enough for any large butterfly larva or a couple of small ones. With very large larva such as those of Sphingidae or Saturniidae, be sure to start with freshly activated desiccant. A larger jar might be required on some of the largest larva. Remember that at best the CaSO_4 can absorb only about $\frac{1}{4}$ of its weight in water.

One piece of equipment not needed in this vacuum freeze-drying system is a large freezer. Several 8 oz. jars can be stored in a home refrigerator freezer and still leave plenty of room for frozen foods.

Procedure

The basic vacuum freeze-drying process consists of the following steps: (1) freezing the larva in the desiccating jar; (2) pulling a vacuum; (3) keeping this jar frozen until the specimens are dehydrated; (4) thawing and releasing the vacuum. Each of these will be discussed in turn.

The first step, freezing the larva, seems fairly simple, but there are a few cautions. Be sure that the jar is tightly sealed. Also, allow plenty of time for the larva to freeze. I usually wait until the next day before pulling a vacuum.

The second step, pulling the vacuum, involves several complications. The first major problem is to determine the amount of vacuum you are creating. The same aspirator will produce widely differing vacuum with different water pressures. One method of checking the vacuum is to connect the aspirator to a simple manometer. Since this involves an added expense (unless you happen to have one laying around the house), I use a less accurate but simpler method. I connect an empty 8 oz. desiccator jar, equipped with a valve, to the aspirator. The water is turned on for 40 seconds, and the valve is closed. Next, the hose is disconnected, the jar and valve are submerged in a pan of water, and the valve is now opened. Water will then rush into the jar. A good aspirator operating with the correct water pressure should create a vacuum sufficient to fill an 8 oz. jar to within $\frac{1}{4}$ oz. of being completely full. This is about 98% full if one is working with another size jar.

Because of changes in water pressure one should check the vacuum just prior to pulling down the desiccator jar. If the faucet is equipped with an aerator, this should be removed to prevent it from reducing the water pressure. Be sure to note the position of the cold water faucet handle when checking the vacuum, so that it can be returned to the same position when the desiccator jar is connected. It is best to work late at night when the water pressure is the highest. A most important aspect in evacuating the desiccator jar is speed. Have everything set up and tested before removing the jar from the freezer. Only 40 seconds are needed to evacuate the jar, and the total time out of the freezer should not exceed one minute.

The third step, keeping the jar in the freezer until the specimens are dehydrated, deserves a few comments. The length of time required is dependent upon numerous factors. The main variables are the temperature of the freezer, degree of vacuum, size of larva, and type of desiccant. In the system I have described, I have found one week insufficient but two weeks adequate for most types of butterfly larva. One last word of

TABLE 3. Comparative costs of freeze-drying systems (1974 U.S.A. prices).

Item	Conventional System	Aspirator System
Pump	\$200.00	\$12.00
Trap	none	0.50
2 Valves	none	5.00
2 Desiccators	50.00	1.00
Freezer	130.00	none
Hose & Connections	7.00	12.00
Total	\$387.00 (minimum)	\$30.50 (maximum)

caution: be sure the jar remains frozen—do not pack warm foods around it.

The last step is to remove the jar from the freezer after sufficient time has elapsed for dehydration. Before letting it thaw, test to be sure the desiccator jar still has a vacuum. I recommend moistening a finger tip and then with the finger over the valve, open and close the valve. If upon removing the finger, a distinct pop is heard, one can be sure the vacuum is still being held. If for some reason there is no vacuum present, one can return the jar to the freezer and repull the vacuum later. If the vacuum has to be repulled, replace the stopper and valve with dry ones just prior to repulling the vacuum. I have found this procedure to be satisfactory as long as the larvae are not allowed to thaw before they are completely dehydrated. Upon removing the jar from the freezer, do not release the vacuum for 24 hours. Experiments I have done indicate that the larvae should be sufficiently dehydrated at this point to prevent discoloration or spoilage, however the wait of 24 hours allows the dehydration to come to a completion. When releasing the vacuum, proceed slowly to avoid collapsing the specimens.

Additional Comments and Results

Since the main reason for using an aspirator vacuum freeze-drying system rather than a conventional system is cost, a comparison of costs is given in Table 3. The figures given are based on 1974 prices. Another benefit of this system is its portability. It weighs less than one pound and can be used anywhere there is running water and a refrigerator freezer.

I have successfully used this system on a wide variety of butterfly and moth larvae. A few suggestions can be made for avoiding poor results. Larvae that are preparing to moult or that are parasitized often do not turn out well. If the frozen larva becomes covered by desiccant,

such as by tilting the jar during the process of pulling the vacuum, the grains of desiccant can dent it. Leaves of larval foodplants can curl during dehydration, therefore when possible avoid putting leaves in the desiccator. Finally a little fading of some colors (especially greens) occurs during vacuum freeze-drying.

ACKNOWLEDGMENTS

A special thanks goes to the late Dr. Richard Dominick for his many helpful suggestions. Two other friends, Mike Rickard and Jim Estep, deserve thanks for their help in the writing and proof reading of this article.

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TWO NEW SPECIES OF PHYCITINE MOTHS WITH DESCRIPTION OF A NEW GENUS (PYRALIDAE)

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***Pimodes* A. Blanchard, new genus**

Tongue well developed. Antenna finely pubescent; on male with a shallow sinus at base of shaft, fringed on both sides with long scales hiding a blunt, black, shiny process on each of four or five segments. Labial palpus porrect, extending at least twice length of head beyond it; second segment closely scaled, more than twice as long as third, longitudinally grooved in male to receive maxillary palpus. Maxillary palpus of male in form of a large aigrette, of female minute, squamous. Scaling of vertex and front forms with labial palpi a streamlined snout. Forewing smooth; cell about two-thirds length of wing; Cu_2 from before lower outer angle of cell; Cu_1 from before angle but close to it; M_2 and M_3 from angle, approximate for about one-fourth their length; discocellular vein extremely weak; M_1 from a little below upper outer angle of cell, straight; R_5 from upper angle, stalked with R_{3+4} for about one-half length of R_5 ; R_2 from cell much closer to stalk of R_{3+4} and R_5 than to R_1 , remaining approximate to this stalk for about one-half its length; R_1 from cell; male without costal fold. Hindwing cell slightly less than half length of wing; discocellular vein weak, deeply concave, greatly extended at lower outer angle of cell; Cu_2 from before lower outer angle; Cu_1 from angle, much shorter than Cu_2 , connate with the stalk of M_3 and M_2 which are anastomosed for about two-thirds their length; M_1 and R_5 anastomosed for some distance beyond upper outer angle of cell; R_5 and Sc approximate for over half the free part of R_5 . Eighth abdominal segment of male with paired, ventrolateral, compound tufts (Fig. 6).

Male genitalia (Figs. 2—5): Uncus hoodlike, its terminal margin notched. Apical process of gnathos a stout hook. Transtilla absent. Valve (Fig. 5) elongate, tapering to bluntly rounded apex; distal fourth of valve virtually reduced to strongly sclerotized costa; sacculus a little over half length of valve, broadest at two-thirds its length from its base; a clasper, rooted in basal third of valve, angled and pointed at apex, runs parallel to costa, is about as wide and half as long as costa. Inner surfaces of sacculus and clasper studded with numerous spinelike hairs. Vinculum much longer than its greatest width, with strongly sclerotized margins. Aedeagus straight, stout, with round, ventral extension at its distal rim; vesica (Fig. 4) armed with one strong cornutus and a bunch of about four smaller cornuti held together by a common sclerotized base. Juxta subquadrate, broadest at base, weakly sclerotized.

Female genitalia (Fig. 7): Bursa almost three times as long as seventh abdominal segment, over three times as long as its average width, slightly bulging ventrally in its middle, membranous except for a sclerotized, scobinate-granulate patch on its left side, cephalad from junction of ductus bursae; this signum is part of the bursa membrane anteriorly, but becomes detached from it and protrudes inside the bursa posteriorly; ductus seminalis from apex of a lobe at caudal end of bursa, left of ductus bursae; ductus bursae about one-fifth as long as bursa, membranous except ventrally at genital opening.

This genus is closest to *Pima* Hulst, but there are significant differences: the third segment of the labial palpus is much shorter than the second in *Pimodes*, about equal in *Pima*; the male maxillary palpus is a large aigrette in *Pimodes*, minute and scaled in *Pima*; M_2 and M_3 of the fore-

wing are approximate in *Pimodes*, separate in *Pima*; the valve has no clasper in *Pima* and its vesica is armed with two subequal cornuti; the ductus bursae is short and membranous in *Pimodes*, long, ribbonlike, sclerotized and granulate in *Pima*. The preceding description, of the male and female genitalia of this new genus, is in fact that of the genitalia of the new species described below. It is understood that, if and when more species are discovered in this genus, a choice will need to be made in order to eliminate those characters which will prove to be specific rather than generic.

***Pimodes insularis* A. Blanchard, new species**

(Figs. 1-7)

Labial palpi closely and thickly clothed with long, whitish tipped, dark gray scales, very slightly paler beneath; apex of head, antennae at base, collar, thorax and tegulae concolorous with palpi above; abdomen ochreous yellow above, yellowish gray beneath; legs mostly concolorous with labial palpi beneath; middle and hind tibiae with long loose scales dorsally. Forewing above with median lines obsolete; basally concolorous with thorax, becoming progressively a little paler distally to still paler fringe; some reddish scales are scattered on the lower half, forming two poorly defined patches at about one-third distance to anal angle; a long, white, fusiform fascie, more or less heavily sprinkled with reddish scales, extends from base to apex, thinning out at both ends, being widest at middle of costa. Hindwing above, translucent grayish white, somewhat darker along costa and on outer margin near apex; a fine dark brownish gray terminal line; fringe white distally and along a fine line at base, darker between. Forewing beneath dark brownish gray, paler basally. Hindwing beneath as above, except fringe entirely whitish.

Wing expanse: 13 specimens, males and females measure 17.5-19 mm; the holotype measures 21 mm.

Male genitalia: As described for the genus.

Female genitalia: As described for the genus.

Holotype: Male, Padre Island National Seashore, Kleberg Co., Texas, 29 September 1975, genitalia on slide A. B. 3636, deposited in National Museum of Natural History, Type No. 73652, A. & M. E. Blanchard collectors.

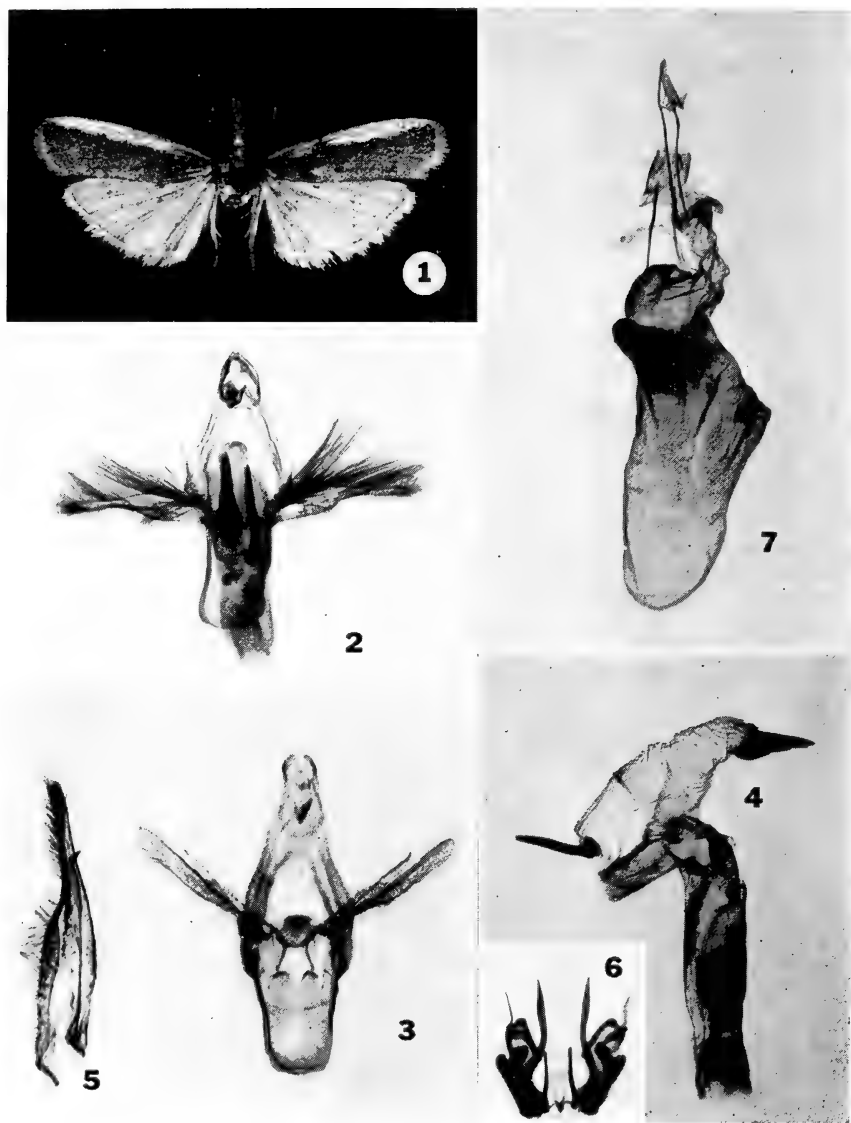
Paratypes: Same locality, 7 July 1975, 1 ♂, 3 ♀♀; 29 September 1975, 3 ♂♂, 3 ♀♀; 2 October 1975, 1 ♂, 1 ♀; 22 June 1976, 2 ♂♂, 1 ♀; 24 June 1976, 2 ♂♂, 1 ♀; 19 July 1976, 2 ♂♂, 16 ♀♀; A. & M. E. Blanchard collectors.

***Macrorrhinia signifera* A. Blanchard, new species**

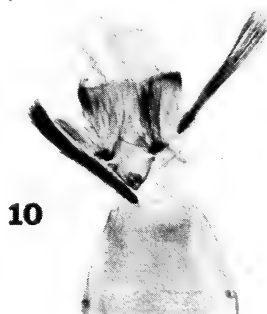
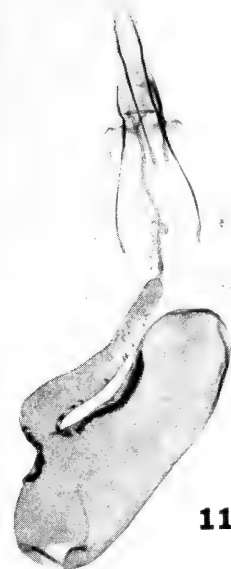
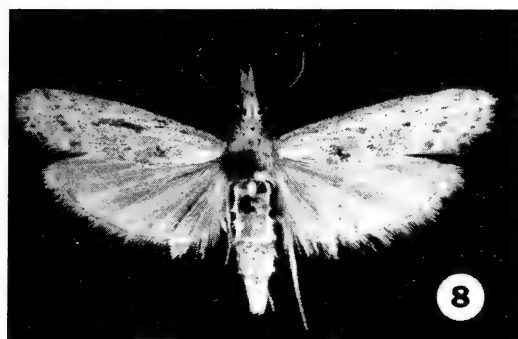
(Figs. 8-11)

I have only five specimens of this new species before me and their maculation is quite variable, hence the description must needs take these variations into consideration.

Palpi, head, collar, thorax and tegulae clothed with pale ochreous gray scales, mixed in variable proportion with darker scales, of same hue in three specimens, definitely reddish in one female and blackish in holotype. Forewing irregularly mottled with scales of same two colors. No recognizable am. band, but where *M. aureofasciella* Ragonot has an orange am. band preceded by a black line, two specimens of new species, including holotype, shows a faint trace of same pattern. Discal dots and pm. line mostly obsolete, except on holotype whose straight, pale pm. line is followed by an array of blackish spots. Terminal line of blackish inter-



Figs. 1-7. *Pimodes insularis*: 1, holotype; 2, male genitalia, most firmly planted outer scales retained; 3, male genitalia, aedeagus removed, outer scales removed using forceps; 4, aedeagus, vesica inflated; 5, inner view of left valve; 6, paired ventrolateral, compound tufts of male eighth abdominal segment; 7, female genitalia.



Figs. 8–11. *Macrorrhinia signifera*: 8, holotype; 9, male genitalia; 10, pair of short ventrolateral hair tufts and lateral pair of eversible lobes with long hair tufts; 11, female genitalia.

venular dots. Fringe concolorous. Hindwing translucent, much paler ochreous than forewing, darker at apex and along upper half of outer margin; fringe concolorous. Forewing beneath ochreous gray, darker along costa and outer margin; terminal intervenular dots as above, fringe concolorous. Hindwing beneath as above.

Wing expanse: 18.5–20.0 mm.

Male genitalia (Fig. 9): Differ from those of *M. aureofasciella* (Heinrich 1956, p. 190, fig. 437) in that the cucullus of the valve is much less broadly expanded and the three distal lobes of the juxta are much narrower.

Female genitalia (Fig. 11): Differ from those of *M. aureofasciella* (Heinrich 1956, p. 190, fig. 924) by the presence of a strongly sclerotized signum consisting of a linear array of minute claws on either side of junction of bursa with ductus bursae.

Holotype: Male (Fig. 8), Town Bluff, Tyler Co., Texas, 7 August 1975, deposited in National Museum of Natural History, Type No. 73651, A. & M. E. Blanchard collectors.

Paratypes: Santa Ana National Wildlife Refuge, Hidalgo Co., Texas, 18 November 1966, 1 ♀; Town Bluff, Tyler Co., Texas, 7 August 1975, 2 ♂♂, 2 ♀♀, Conroe, Montgomery Co., Texas, 9 September 1975, 1 ♀, A. & M. E. Blanchard collectors.

Only two species of the genus *Macrorrhinia* have yet been described: *M. aureofasciella* Ragonot (Ragonot 1901, p. 190) and *M. placidella* (Zeller) (Zeller 1848, p. 874). The preceding comparative description leaves no doubt that the new species is different from *aureofasciella*. Dr. D. C. Ferguson made for me a sketch of the habitus of *M. placidella* figured in Ragonot (1901, p. 190); comparing this sketch with my specimens of the new species leaves no doubt that they are different.

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THE BIOLOGICAL STATUS OF NEARCTIC TAXA IN THE
PIERIS PROTODICE-*OCCIDENTALIS* GROUP (PIERIDAE)

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The taxonomy of *Pieris protodice* Boisduval & LeConte and its relatives in western North America has long been confused, with the relationship of that taxon to *P. occidentalis* Reakirt being a matter of particular contention. Both current "field guides" (Klots, 1951; Ehrlich & Ehrlich, 1961) treat them as conspecific, as does the North American check-list (dos Passos, 1965), while recent faunistic papers by authors in western North America (e.g., Garth & Tilden, 1963) have regarded them as separate species. Chang (1963) provided morphological evidence in support of the latter position and mapped the distribution of *P. occidentalis*. His analysis was followed by Howe (1975). The situation is complicated by the occurrence of named seasonal and/or altitudinal phenotypes in both, as well as one valid subspecies. The present paper summarizes the result of a series of field and laboratory studies in which the biological relationships among these entities have been clarified; these studies are cited individually in the text. It is not intended as a formal taxonomic revision; such a revision should, if undertaken, be on a world-wide basis. All of the taxa are abundantly illustrated in the papers cited.

The only previous American treatment of this group was by Abbott (1957) and Abbott, Dillon, & Shrode (1960). This incompetent study, which "synonymizes" the very different species *Pieris beckerii* Edwards and *P. sisymbrii* Boisduval with *P. protodice* and *P. occidentalis* with total disregard for their biology and extensive sympatry, makes no useful contribution to the taxonomy of the group. Those names in the group which were authored by William H. Edwards have been very thoroughly treated taxonomically by Brown (1973). McHenry (1962) has prepared a bibliography of the original descriptions of all taxa placed in *Pieris* in North America.

The biological entities recognized in this paper are:

- I. *Pieris protodice* Boisduval & LeConte
f. vern./aut. *vernalis* W. H. Edwards
nasturtii "Boisduval MS." (W. H. Edwards)
- II. *Pieris occidentalis* Reakirt
f. vern./aut./alt. *calyce* W. H. Edwards
IIA. ssp. *nelsoni* W. H. Edwards

I. *Pieris protodice* Boisduval & LeConte (Fig. 1).

1829. Hist. Gen. Icon. Lepid. Chen. l'Amer. Sept. 1(5): 45-46; pl. 17, figs. 1-3. Type locality New York and Connecticut. Both sexes described and figured.

The type locality makes this name biologically unambiguous, as there is only one member of this species-group in the eastern United States. *Pieris protodice* is distributed over most of the U.S. generally below 2000 m but reaching 3000 m in New Mexico and Arizona. It is absent from the Pacific Northwest, north of the Central Valley of California, and from the northeastern states north of southwestern and southeastern Pennsylvania except along the immediate coast, north rarely to Massachusetts. It occurs in southern Ontario, at least sporadically. Its northern and upslope borders are extremely unstable; in cold-winter areas it is generally dependent on immigration and although it may breed, it overwinters only exceptionally. It is reported southward to southern Baja California, and on the mainland to Guatemala (Hovanitz, 1962), but is rare or absent in subtropical Florida although it has been collected on Cuba. It is striking that Boisduval recorded this species, along with *Colias eurytheme* ("edusa"), so far north so early. We will probably never know whether they occurred naturally or had already been introduced from further south.

Pieris protodice is always associated with sunny, warm, and dry environments. It is a "weedy," "colonizing," or "fugitive" species commonly found in highly disturbed, early-successional habitats, especially on sandy soils—often by roadsides, along railroad rights-of-way, or in urban vacant lots. In the west it often occurs in the dry washes and around corrals. In the northeast it is frequent on beaches. In most of its range its preferred hosts are the annual or winter-annual cruciferous weeds *Lepidium virginicum* L. and *L. densiflorum* Schrad. In California at low elevations it breeds extensively on *Brassica geniculata* (Desf.) Ball where no summer *Lepidium* spp. grow, and on the southwestern and Great Basin deserts on native *Lepidium* spp. and *Physaria* spp. and on *Sisymbrium altissimum* L. It rarely breeds on *Brassica nigra* (L.) Koch (a misdetermination by Hovanitz, 1962) but is capable of accepting a great variety of crucifers in captivity.

Pieris protodice is not known to be a permanent resident anywhere where the breeding season is too short for multiple broods. It has four to six broods in central California and about four at New York and Philadelphia. It is always much commoner and more widespread in late summer and autumn than earlier in the season. Winter is spent as a pupa in diapause under photoperiodic control.

Stocks of *P. protodice* from California, Arizona, Colorado, Texas, New

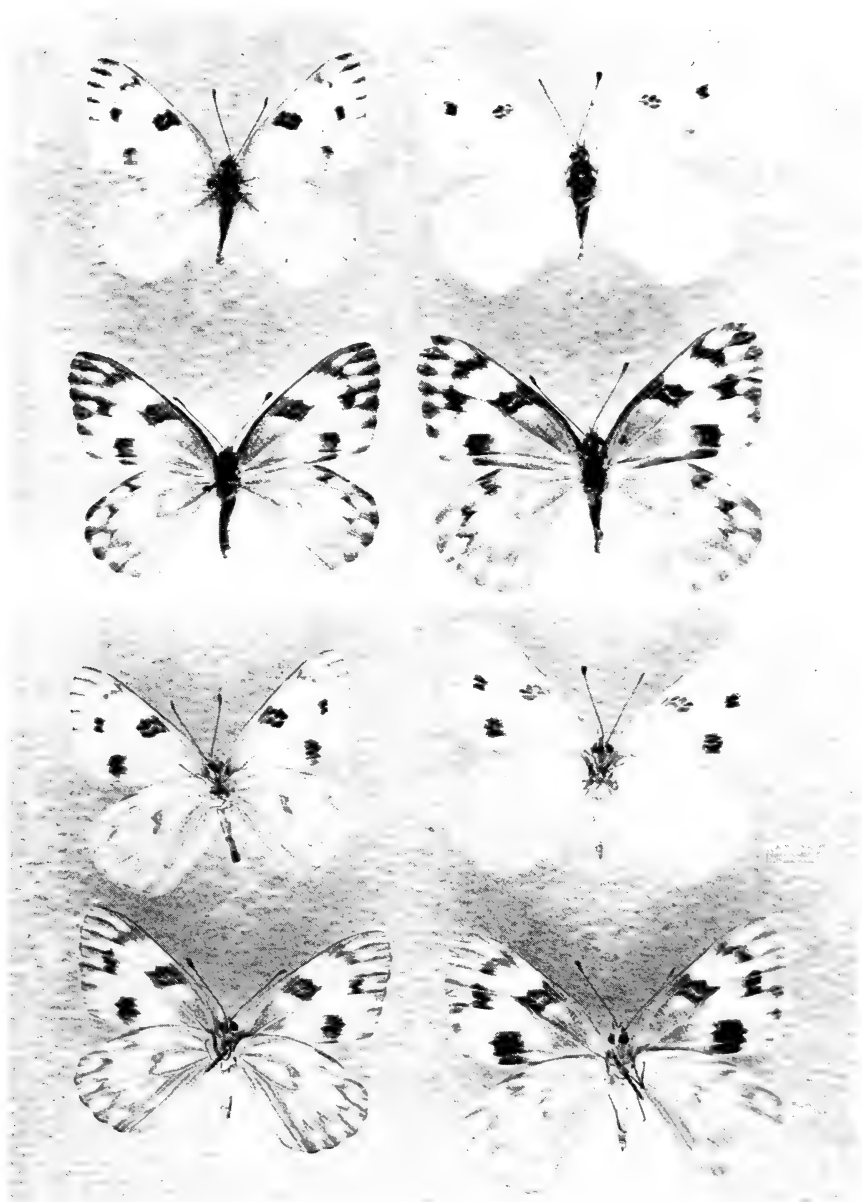


Fig. 1. *Pieris protodice* from New York (left-hand pair) and California (right-hand pair), summer phenotypes, dorsal and ventral surfaces. The New York male is phenotypically "intermediate," similar to the description of male *nasturtii* (see text).

Mexico, Pennsylvania, New Jersey, and New York have been crossed in various combinations with no significant loss of fertility or viability in continuous culture; wide geographic crosses may, however, disrupt the diapause response (Shapiro, unpublished).

Aspects of the biology of *P. protodice* in California are discussed in Shapiro, 1975a and of its reproductive biology in Shapiro, 1970.

Pieris vernalis W. H. Edwards (Fig. 2).

1864. Proc. Ent. Soc. Phila. 2(4): 501-502. Type locality Red Bank, N.J. (May). Both sexes described.

This is the phenotype of *P. protodice* which is produced when the larva develops on a long-night regime, regardless of temperature, and may be induced in the progeny of any female of any brood by appropriate treatment (Shapiro, 1968). Its production is not dependent on the occurrence of diapause, which may be inhibited under inducing photoperiods by high temperatures. Intergrades to the *vernalis* phenotype, and occasionally quite dark examples, are thus produced in autumn. This phenotype has not been reported for many localities where the summer broods of *P. protodice* occur; this is scarcely surprising given the fugitive nature of populations in this species. There are no differences in the expression of the phenotypes in Californian and northeastern stocks.

No type of *Pieris vernalis* exists. Despite information given Brown (1973) by New Jersey collectors, *Pieris protodice* is by no means "nearly extinct" in that state; in 1965 I collected over 500 in an afternoon in Camden. I have not, however, seen specimens of *vernalis* from Red Bank or elsewhere in Monmouth County, although I have several from nearby Staten Island. Because Staten Island is in New York state, I have refrained from designating any of these as a neotype in the hope that a genuine Red Bank specimen may turn up.

Pieris nasturtii W. H. Edwards.

1864. Proc. Ent. Soc. Phila. 2(4): 501. Type locality San Francisco, California. Both sexes described.

This was a Boisduval manuscript name, resurrected by Edwards. Its tangled history is given by Brown (1973). Apparently Boisduval applied it to an animal in the *Pieris napi* group, but the specimens sent by Behr to Edwards as "*nasturtii*" were "an odd variety of *protodice*," as Edwards later wrote. No type, nor any specimen which can definitely be linked to this name, is extant.

The only member of this group found in or near San Francisco is *P. protodice* (except for the possible occurrence of *P. occidentalis* in the Santa Cruz mountains, see below). The descriptions strongly sug-

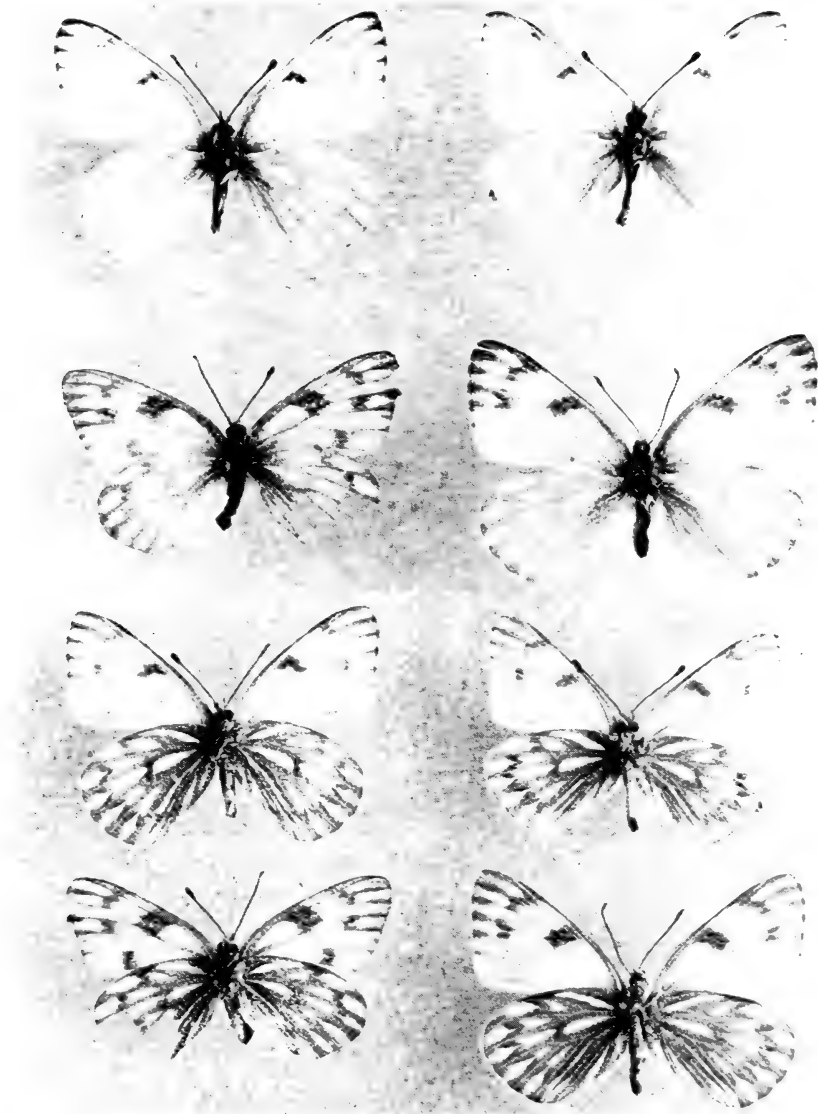


Fig. 2. *Pieris protodice* from New York (left) and California (right), *vernalis* phenotypes, dorsal and ventral surfaces.

gest the late September–November phenotypes of Bay Area *P. protodice*, which are somewhat transitional to *vernalis*. The “coppery” color of the female is characteristic of old, faded-in-life specimens, as is the hyalinity. It thus appears that the name *nasturtii* W. H. Edwards refers to the

autumn brood of *protodice* and is, thus, infrasubspecific and without taxonomic standing. Its revival would in no way benefit taxonomy or biology, especially since variation from summer to winter phenotypes is essentially continuous in autumn in continuously breeding populations. In my publications the male description of *nasturtii* applies to my "intermediate" phenotypic grade.

II. *Pieris occidentalis* Reakirt (Fig. 3).

1866. Proc. Ent. Soc. Phila. 6: 133-134. Type locality "Rocky Mountains, Colorado Territory, California." Both sexes described.

Pieris occidentalis occurs upslope and northward of *P. protodice* in western North America. The two species have been found sympatric at various locations from 1000-2500 m in the Rocky Mountains and Sierra Nevada, e.g., Donner Pass, California, where *P. occidentalis* is a permanent resident and *P. protodice* a breeding immigrant (Shapiro, 1975a). *Pieris occidentalis* ranges from Arctic Alaska and adjacent Canada south at increasing elevation to the southern Sierra Nevada of California and the Colorado Rockies (both above 2000 m), east to the Black Hills of South Dakota. It may extend into northern New Mexico. Its eastern limits in Canada are poorly understood. Its southern extent in the California Coast Ranges is unknown; it may reach Santa Cruz County, where it was apparently collected (by M. Doudoroff?) in 1930 (U. C. Berkeley collection). However, I have not seen any other Coast Range specimens from Mendocino County southward.

As noted in the introduction, Chang (1963) has described morphological differences between these two species. There are useful color and pattern differences; both sexes characteristically are more heavily and completely marked in *P. occidentalis* than in *P. protodice*; the wings of *P. occidentalis* appear thicker and more heavily scaled; the body is proportionally larger and usually hairier. The larva is more contrastingly colored and the pupa tends to be shorter and broader than in *P. protodice*. The chaetotaxy is uninvestigated. In areas of sympatry occasional interspecific matings may occur, but only 2 of 339 specimens collected at Donner Pass in 1973 were phenotypically ambiguous (Shapiro, 1975a). Although conspecific pairs are readily formed in cages, interspecific ones are not.

Pieris occidentalis is characteristically found at low densities in mountainous regions, where most captures are of "hilltopping" males. It normally breeds on montane crucifers such as *Arabis* and *Streptanthus* species and *Thlaspi alpestre* L., but becomes "weedy" and breeds at high density when presented with the opportunity, as in the railroad yard at

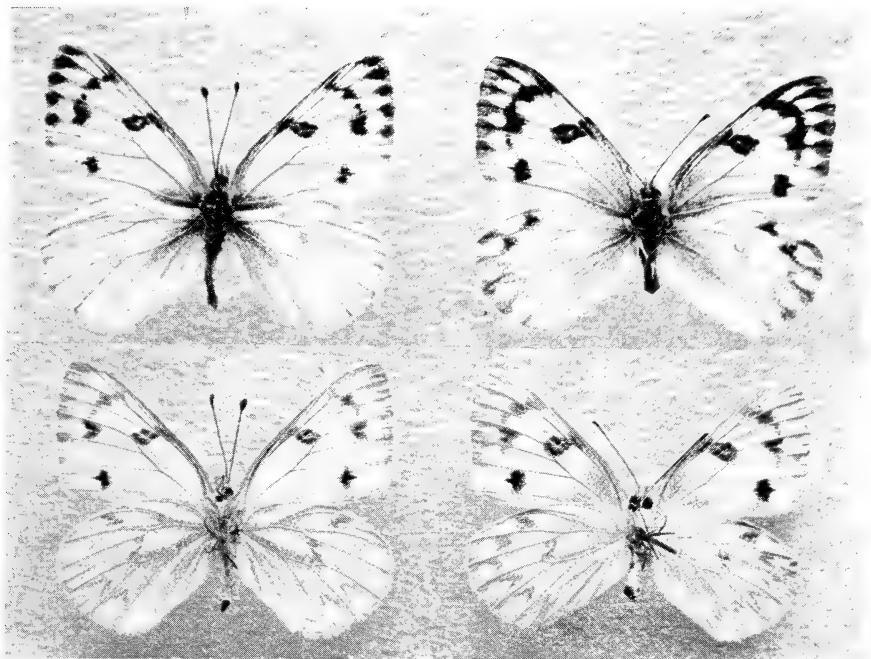


Fig. 3. *Pieris occidentalis* from the California Sierras, summer phenotypes, dorsal and ventral surfaces.

Donner Pass where its host is *Lepidium virginicum*. It is double-brooded at moderate elevations southward and possibly partially triple-brooded at its lower elevational limit in both Colorado and California (see below). Winter is spent as a diapausing pupa.

Pieris calyce W. H. Edwards (Fig. 4).

1870. Trans. Amer. Ent. Soc. 3, signature 25: 189, no. 1. Type locality "Nevada," restricted by F. M. Brown (1973) to vicinity Virginia City, Nev. Male described.

Edwards (1876) speculated that *calyce* might be a spring form of *Pieris occidentalis*, and in this he was correct. Brown (1973) demonstrates that the type was probably collected by Henry Edwards at Virginia City (elev. 1921 m) in March 1868 or 1869. At Virginia City a March specimen would be a very early example of the phenotype emerging from overwintering pupae in a bi- or trivoltine population of *occidentalis*. In such populations Shapiro (1973) has shown that *calyce* is the equivalent of *vernalis*, a seasonal, photoperiod-induced phenotype (although in *occidentalis* the control is less absolute). It can thus be obtained in the laboratory from the progeny of any female *occidentalis*. In its original

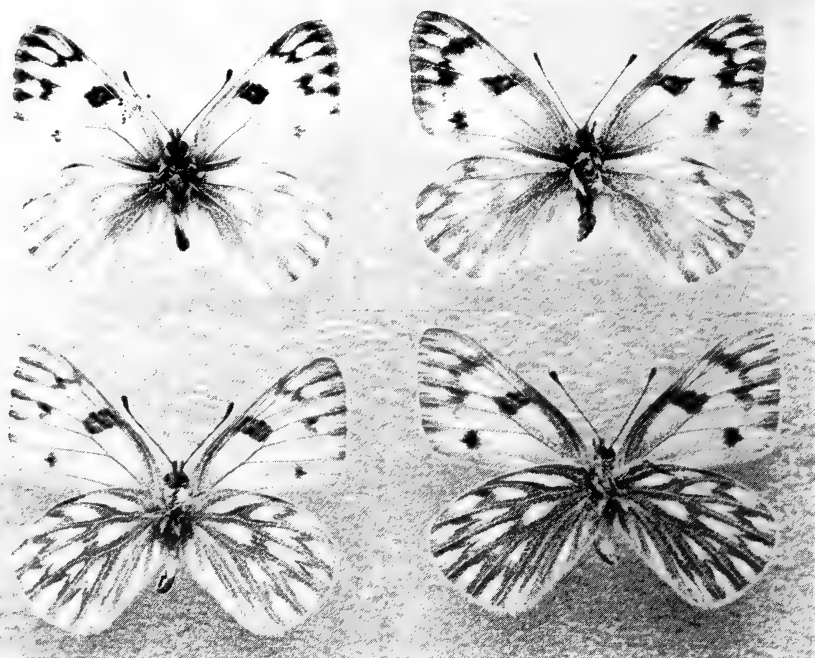


Fig. 4. *Pieris occidentalis* from the California Sierras, *calyce* phenotypes, dorsal and ventral surfaces.

sense, then, although proposed as a species-group name, *calyce* clearly refers to a seasonal phenotype and is infrasubspecific.

The name *calyce* has been used by some authors (e.g., Garth & Tilden, 1963) in a subspecific sense to apply to the univoltine animal of this group which occurs at or above tree-line in the Rockies, Sierras and Great Basin ranges. This animal is phenotypically indistinguishable from specimens collected one or two months earlier 1000 m lower. When stock of univoltine "*calyce*" from Loveland Pass, Colorado (3600 m) was reared under continuous light at 25°C it did not diapause, but developed directly in less than a month and produced light, *occidentalis* "summer" phenotypes (Shapiro, 1975b). These animals were successfully crossed with *P. occidentalis* from Donner Pass, California, with no decrease in fertility or viability. An apparently spring-univoltine "*calyce*" stock from Haystack Mountain in the eastern foothills of the Colorado Rockies has also been studied (Shapiro, 1976b).

The various populations of univoltine "*calyce*" are completely disjunct from one another on mountaintops. Present evidence implies that

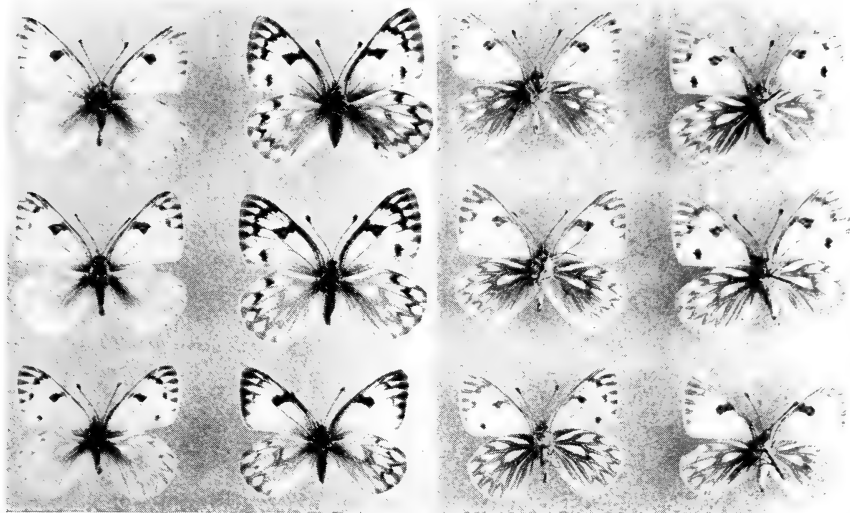


Fig. 5. *Pieris occidentalis nelsoni*, Fairbanks, Alaska, dorsal and ventral surfaces.

each is independently derived locally from the multivoltine populations found downslope from it. Whether or not one is willing to accept “polytopic” subspecies, the use of *calyce* as a subspecific name is rendered inappropriate by the holotype data presented by Brown and should be discontinued. The name *calyce* is appropriately applicable to a phenotype, not a population.

Univoltine high-elevation populations have been found associated with *Thlaspi alpestre* and *Smelowskia calycina* (Desv.) Meyer in Colorado and *Erysimum perenne* (Wats. ex Cov.) Abrams at Sonora Peak, California. No definite host records are known to me. *Erysimum* is not a normal *Pieris* host (Chew, 1975), though *P. rapae* has been found on it at least once (Shapiro, 1975a).

IIA. *Pieris occidentalis nelsoni* (Fig. 5).

Pieris nelsoni W. H. Edwards.

1883. Butt. North America 2(11): 71, pl. 15, *Pieris* I, figs. 6, 7. Type locality St. Michael's, Alaska. Male described and figured.

This entity has been “lost” since its original description, although many reports of *P. occidentalis* in Alaska have been made. In July 1974, I studied a population at Fairbanks, Alaska in which “*nelsoni*” is the most frequent male phenotype, and subsequently bred it in the laboratory, crossed it with Sierran *occidentalis*, and obtained genetic data which are being reported elsewhere (Shapiro, 1976a). The *nelsoni* phenotype is

expressed with or without diapause. Ventrally, *nelsoni* is about as dark as *calyce*, but some specimens reared without diapause are as light as summer *occidentalis* (Shapiro, 1975c).

St. Michael's, now St. Michael, is on the south coast of Norton Sound in western Alaska. Now that *nelsoni* has also been found in interior Alaska, it appears that it is not an aberration but a valid and recognizable geographic subspecies, and I so treat it. It remains to be seen how far it extends into western Canada and the nature of its contact with nominate *occidentalis*. Some *nelsoni* characters are recognizable in populations of *occidentalis* as far south as Modoc Co., California (Shapiro, unpublished).

P. o. nelsoni has some resemblance to the *vernalis* phenotype of *P. protodice*, especially in the male. This is presumably the basis for its classification as a subspecies of *protodice* by Howe (1975). Although *nelsoni* has not been tested genetically with *protodice*, its conspecificity with that taxon can be ruled out on Chang's characters, on the shape of the pupa, and on geographical grounds—*nelsoni* is distributed some 2000 mi. from the nearest known *protodice* populations, and in a totally different climatic and vegetational region.

The only confirmed host of *nelsoni* is *Lepidium densiflorum*, a weed in the railroad yard at Fairbanks. As noted in Shapiro, 1975c and 1975d there is reason to suspect that this population may be facultatively bivoltine.

Relationships with Palaearctic Taxa

Higgins & Riley (1970) treat *P. occidentalis* (and by implication *P. o. "calyce"*) as subspecies of the Palaearctic *Pieris callidice* Hübner. Brown (1973) follows this usage, under which there would be two Nearctic subspecies, *occidentalis* and *nelsoni*, as interpreted in the present paper. There are no genetic data bearing on the relationship. It is evident that there is great phenotypic similarity among these taxa, particularly between *callidice* and *nelsoni*. All populations of *callidice* known to me have a yellow ventral hindwing, a character unknown in any North American population; in this respect they parallel many Palaearctic members of the *Pieris napi* complex. W. H. Edwards wrote Henry Edwards concerning Nelson's specimen, March 15, 1882: "There is 1 male *Pieris* which I think is certainly *Callidice*. The upper side agrees perfectly with a male *Callidice* I have from Europe. The underside is not so heavily green dusted on the nervures and branches. If this is *Callidice*, it is the first American example I ever saw." The plausibility of the conspecificity hypothesis is increased by a report from K. M. Philip,

of the University of Alaska, that he has a male *callidice* from the River Omolon, Magadansk Oblast, NE Siberia—bridging the gap between the Alaskan populations and the nearest *callidice* recorded by Higgins and Riley, in Mongolia. It is very likely that further study will confirm the Higgins-Riley-Brown usage.

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POPULATION STRUCTURE OF THE PRIMROSE MOTH,
SCHINIA FLORIDA (NOCTUIDAE)STEVEN N. HANDEL¹Section of Ecology and Systematics, Comstock Hall,
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The primrose moth, *Schinia florida* (Guenée), uses the evening primrose, *Oenothera biennis* L. (Onagraceae), as both a larval food plant and a resting and oviposition site for adults (Hardwick, 1970). Larvae and adults are well-known mimics of the developing seed capsules and the flower petals (Kellicott, 1879; Hardwick, 1970).

As many species of the Heliothidinae are associated with flowers (Hardwick, 1958), and may be of considerable importance to the reproductive biology of their hosts, I conducted a study of *S. florida* at an isolated population of *O. biennis*, including a capture-mark-recapture study during the summer of 1975.

Study site. I conducted mark-release-recapture work at a population of *O. biennis* of approximately 2000 plants. This population was on a rocky island in the middle of Six Mile Creek, Tompkins Co., New York, 320 m E from Van Natta's Dam. The island was 112 m long and 16–28 m wide. It was formed during the extensive flooding of Six Mile Creek during June 1972. The island was covered with a diverse array of colonizing plants. I identified 16 woody and 73 herbaceous species present in July 1975. The dominant woody species included 32 staghorn sumac (*Rhus typhina* L.) and 27 black locust (*Robinia pseudo-acacia* L.) saplings and many aspen (*Populus deltoides* Marsh.) shoots.

O. biennis was the most conspicuous and common herb. Many sweet clover (*Melilotus alba* Desr.) plants were also present.

The ravine surrounding the island contains an unlogged beech-maple forest. No other populations of *O. biennis* were found in this section of the ravine from Van Natta's Dam to the Ithaca City reservoir, except for one small cluster of 160 plants at the head of the dam.

Population parameters. Daily, from 7 July–26 July 1975, I slowly paced across the island, examining each *O. biennis* plant for *S. florida* adults. These moths can easily be seen resting in or near the flowers. All moths found were caught and numbered with a marking pen, using the standard techniques (Ehrlich & Davidson, 1960). Moths first were found on the island 7 July and were last seen 25 July. This period closely matched the peak flowering time of *O. biennis*. During this period 53 moths (25

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TABLE 1. Population parameter estimates of *Schinia florida* at the Six Mile Creek study site.

Date	Alpha ¹	M ²	N ³	Phi ⁴	B ⁵
July 7	0.00	00.0	*	0.29	*
8	0.29	2.0	7.0	0.14	*
10	0.00	1.0	*	1.00	*
11	0.50	2.0	4.0	0.75	9.0
12	0.25	3.0	12.0	0.71	10.6
13	0.22	4.3	19.1	1.00	10.8
14	0.43	17.0	39.7	0.14	1.3
15	0.43	3.0	7.0	0.14	3.0
16	0.25	1.0	4.0	0.25	3.0
17	0.25	1.0	4.0	0.25	1.0
18	0.50	1.0	2.0	0.00	*

¹ Proportion of marked animals.² Total marked population.³ Total population.⁴ Probability of survival.⁵ Number of new animals joining the population.

* Insufficient data to allow calculation.

♂, 28 ♀) were found and marked. Of these, 5 males (20.0%) and 8 females (28.6%) were recaptured at least once. No moth was recaptured more than three days after its first capture; 11 moths were recaptured one or two days after marking.

Table 1 summarizes data from this population, using statistics from the stochastic model of Jolly (1965). The size of the population (N) peaked at about 40 animals on 14 July, then rapidly fell. Although 2-3 moths were found 19-21 July, no moths were found 22-24 July; 2 found on 25 July were the last seen that summer. These captures from the end of the flight season are too few to permit inclusion in the Table 1 analysis. The short flight season of the adults complements a short development period from egg to pupa. Hardwick (1970) reported a 25 day period from egg to pupa in his laboratory rearing. In my study, average survival rate was .58, which corresponds to an expected life-span of 3.26 days (Cook et al., 1967). Most recaptured animals looked extremely pale, and many had tattered wing edges.

Additional observations. Among the moths captured in this study were 12 male-female pairs resting in the same or adjacent flowers. After marking and release, most moths quickly flew down to the lower leaves of herbs within a few meters of the release point. A few animals flew several meters down the island.

On 20 July, I surveyed roadside *O. biennis* populations in Tompkins Co. I found 75 populations of 1-9 plants, of which only 4 (5.3%) contained *S. florida* individuals. Five of nine larger plant populations (10-59 individuals) contained *S. florida*, as did one cluster of 170 plants.

Much larger densities of this moth are occasionally seen in certain years and in certain areas (J. G. Franclemont and T. McCabe, pers. comm.). I have also seen *S. florida* adults sequestered among *Gaura biennis* L. (Onagraceae) flowers along Six Mile Creek. *Gaura* and *Oenothera* have very different floral morphologies and color, although they contain the same pigment, isosalipurposide, in their petals which produces ultraviolet patterns (Dement & Raven, 1973, 1974).

Conclusions. *S. florida* has short lived adults, that rapidly leave, by death or migration, the plant population where they have eclosed. This behavior is not unexpected for insects which rely on early successional or ephemeral food plants (Brussard & Ehrlich, 1970). The close association of *S. florida* with *O. biennis* flowers, and the moths' possible movement from plant to plant and among populations may allow for pollen movement between these plants. Pollen is often found brushed on the moths' thorax. Although *O. biennis* is a well-studied case of a self-pollinated plant with special cytogenetic features (Cleland, 1972), there are experimental results showing that crossing will occur at a regular low rate in test gardens of diverse *O. biennis* races (Hoff, 1962). Also, isozyme investigations confirm that small amounts of crossing do occur (Levin, 1975; Levy and Levin, 1975). A vehicle for such pollen movements is needed; *S. florida* is a likely possibility.

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FEMALE ANAL HAIR TUFT IN *NORDMANNIA MYRTALE*
(LYCAENIDAE): EGG-CAMOUFLAGING FUNCTION AND
TAXONOMIC SIGNIFICANCE

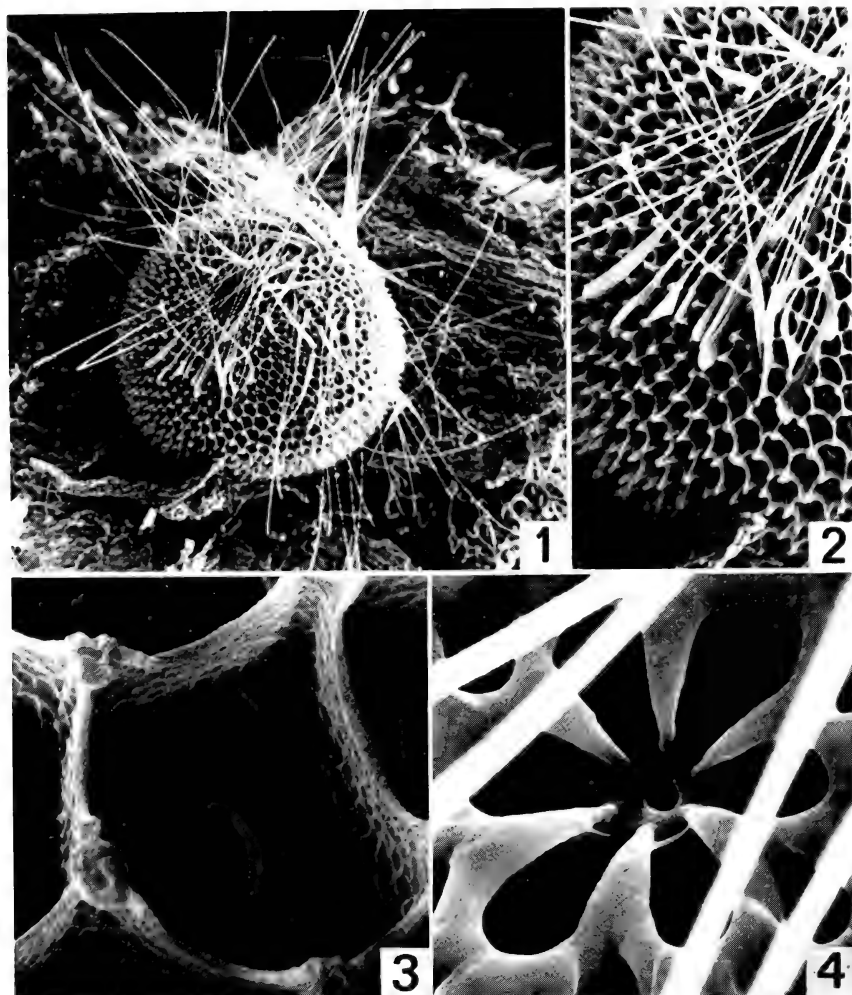
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Females of certain Palaearctic eumaeinid butterflies have a cluster of specialized scales, the so-called anal hair tuft, at the tip of their abdomens. The best known example is the South European *Nordmannia acaciae* (Fabricius). The actual function of the structure apparently remains undocumented, even though similar structures in other genera (see below) are known to be used for camouflaging eggs with the scales. The purpose of this short note is to show that the female anal hair tuft of a closely allied species, *Nordmannia myrtale* (Klug), does function as an egg-camouflaging device. The taxonomic significance of the hair tuft will also be discussed briefly, as the genus *Nordmannia* Tutt traditionally includes species with and without the structure in the female (Tutt, 1907; Higgins, 1975). *N. myrtale* is the type species of the genus.

N. myrtale was originally described from "Syria" (today's Lebanon) and its range extends to Turkey (A. Koçak, unpublished) and perhaps to Armenia (*armena* Rebel). The southern distribution limit is Mt. Hermon on the frontier (since 1967) of Lebanon, Syria, and Israel where it occurs above c. 1600 m on the southern slopes. The food plant found at 2000 m is *Cerasus prostrata* (Lab.) Ser. (Rosaceae), a typically Irano-Turanian subalpine dwarf shrub from the plant geographical point of view. In late June 1975, some freshly laid eggs were obtained from the plants. Several shells and dead eggs (some parasitized) remaining from the previous year were also found. As usual in this group, the eggs were located on wrinkled parts of the twigs and at branching points. Some were as close to the ground as a few centimeters; the plant itself is only 20–30 cm high.

Interestingly enough, the fresh pale brown eggs were invariably covered with long scales (Fig. 1), although weathering left only a few damaged scales or none at all on the old shells and dead eggs. The morphology of the scales on the eggs corresponds exactly to those of the female abdominal tip. Such egg-camouflaging is presumably a defense mechanism against parasitic insects and predators, although its effectiveness could be questioned in certain cases (see below). It also seems likely that the female anal hair tuft has other functions as well: in *Nordmannia* the color of the hair tuft is either black or white de-



Figs. 1-4. Egg of *Nordmannia myrtale* (Klug) (Mt. Hermon, 2000 m, 28. vi. 1975; on *Cerasus prostrata*; I. N. leg.): 1, whole egg in situ, magnification $55\times$ (egg diameter 0.72 mm); 2, the same, part, magnification $123\times$; 3, cell structure, magnification $1320\times$; 4, micropyle, magnification $1320\times$.

pending on the species and therefore it contrasts conspicuously with the rest of the abdomen, suggesting a role in courtship.

Morphologically the egg (Figs. 1-4) resembles those of related species but differs in a number of structural aspects (for SEM photographs of an egg of *spini* Denis & Schiffermüller group, usually included in genus *Strymonidia* Tutt, see Nakamura, 1976). Since the egg provides ex-

tremely useful taxonomic characters, its fine structures are also included in the figures. The number of radiating micropylar cells varies between five and six.

Certain other groups of butterflies are also known to camouflage eggs by an analogous method, usually but not always in association with a grossly visible anal hair tuft. They include the following Palaearctic, Oriental and African genera of Lycaenidae and Hesperiiidae: *Japonica* Tutt (Theclinae, Theclini) in which the two Japanese species lacking a conspicuous hair tuft collect dust as well as scales to conceal the eggs, although rather poorly (see e.g., Shirozu & Hara, 1960-62); *Chaetoprocta* de Nicéville (Theclinae, Theclini) in which the female of the sole species of the genus carries a conspicuous hair-tuft and uses it effectively for camouflaging eggs (Wynter-Blyth, 1957); *Daimio* Murray (*sens. str.*) and *Tagiades* Hübner (Pyrginae, *Tagiades* group) in which the eggs of known examples are covered by scales to such an extent that the shell may not be visible at all (see e.g., Shirozu and Hara, 1960-62). The species of the African genus *Pseudaletis* Druce (Theclinae, Aphnaeini) have a female anal hair tuft, but a camouflaging function does not seem to be on record (Stempffer, 1967).

Thus, the degree of perfection in camouflaging eggs differs considerably among genera; the way it is achieved may also vary. According to Wynter-Blyth (1957); the scales stick to the egg automatically as the female *Chaetoprocta odata* (Hewitson) lifts the abdomen from the egg. To my knowledge, the females of *Daimio* and *Tagiades*, as well as *Japonica*, make deliberate efforts to conceal their eggs. I have not witnessed the oviposition behavior of *N. myrtale*, but the orientation and clustering of scales on the egg (Fig. 1) clearly mark several brushing strokes by the female abdomen. It is therefore possible that the egg-camouflaging behavior and the anal hair tuft have evolved partly independently of each other. The sporadic presence of the female anal hair tuft in widely separated genera indicates that it is a case of convergence as previously suggested (Eliot, 1973). Yet, it is of interest to note that the two Theclini genera mentioned above have been considered to be rather primitive on structural grounds (Shirozu & Yamamoto, 1956).

Regardless of its evolutionary significance, the hair tuft as a taxonomic character seems to be constant within each of the genera and calls for a re-examination of the current view of the genus *Nordmannia*. The genus as originally introduced (Tutt, 1907) and as currently in use (Higgins, 1975) is based on characters of doubtful significance, and consequently includes heterogeneous elements. Therefore, it is worth

pointing out that the species possessing female, anal hair tufts comprise, on other grounds as well, a homogeneous group distinct from those without such structure (*ilicis* Esper, *esculi* Hübner).

Firstly, the specific status of many named forms in the *myrtale-acaciae* group is still obscure due largely to their extreme superficial uniformity and practically identical genitalia. On the other hand, *ilicis* and *esculi* were once considered as conspecific, reflecting their superficial resemblance. Although the genitalia of both groups are internally quite uniform, there are some notable differences between the groups as, for instance, in the phallus. Geographically, *ilicis* and *esculi* are typically Mediterranean in distribution, although the former has established itself in Central Europe as have several other Mediterranean species. The *myrtale-acaciae* group is centered within the area conveniently called the Irano-Anatolian region of the Middle East. Again, the extension of *acaciae* into Southwest Europe along the northern shore of the Mediterranean has a number of parallel examples among groups centered in the Middle East. This is evidently due to the climatic history of the Mediterranean region (e.g., Bonatti, 1966) and the persistence of similar ecological niches in the two regions today. Ecologically, the *ilicis-esculi* group is basically an inhabitant of warm, relatively mesic Mediterranean maquis and forests, associated with evergreen, sclerophyllous oaks which are the main larval food plants of *ilicis* (those of *esculi* are apparently unknown). The fact that *ilicis* has been reported to feed on *Prunus* L. is hardly surprising since food plant specificity seems relatively plastic in the whole group of related genera. This is probably one of the factors that permitted northward expansion of *ilicis* in Europe. In contrast, the *myrtale-acaciae* group prefers, as a whole, more xeric habitats and is better adapted to the cold, being associated with certain vegetation types such as steppe forest characteristic of Irano-Anatolian region. The food plants are *Prunus* L., *Crataegus* L. (for *acaciae* in Yugoslav Macedonia; Nakamura, unpublished observation), and other arboreal Rosaceae. There is as yet no indication of oaks being utilized by this group. In short, the *myrtale-acaciae* group and the *ilicis-esculi* group are natural groups distinct from each other by criteria which may justify generic separation. It is a matter which should be decided in a revision of the entire, much larger group of related genera.

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NOTES AND NEWS

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G. L. GODFREY
Editor

GENERAL NOTES

ECOLOGICAL NOTES ON *CELASTRINA EBENINA* (LYCAENIDAE)

Among plebejine blues, *Celastrina ebenina* Clench is notable for having females that are partly lustrous pale blue above, whereas the males are dull blackish or grayish-brown: the reverse of the usual situation in species with dimorphic sexes. This taxon (for which an appropriate English common name might be "dusky azure") was not recognized as a species until 1972. Its geographical range, however, extends roughly from Indiana to Pennsylvania, south to North Carolina, biologically one of the better known regions in North America. Compared with its close relative, *Celastrina pseudargiolus*, the new species is rare and local, known from only 13 localities (including several new ones reported below).

We attempted to obtain information on habitat and behavioral differences, if any, between the rare species and the common species. Where *C. ebenina* occurs, *C. pseudargiolus* is apparently always present. Wagner visited two *C. ebenina* localities in the spring of 1975. The first of these was an unreported one discovered by Showalter in Poverty Hollow, Montgomery Co., Virginia. Showalter took a single male there in flight on 23 April 1972, and the following year another single male was taken at the same spot on 15 April. Efforts to rediscover the butterfly in Poverty Hollow during 13–15 April 1975 failed, even though such other butterflies as *C. pseudargiolus*, *Glaucopteryx lygdamus*, *Pyrgus centaurae*, and an unidentified *Callophrys* were flying. The precise spot where Showalter found his specimens was revisited many times but without results. The habitat is a dry second-growth area where burning and logging took place a few years ago. Now it is grown up with young pines, brambles, and various acid-soil members of the heath family such as blueberries. It seems possible that the individuals found were casuals, and that the metropolis of the species in Poverty Hollow is elsewhere, perhaps in a more mature hardwood forest area nearby.

On 3–5 May 1975, Wagner went to Clench's locality near Zaleski, Vinton Co., Ohio (Clench 1972, Ann. Carnegie Mus. 44: 33–44) and, following his directions (*in litt.*), located the exact site. The first two days were cloudy, and only a few butterflies were observed. On the third day the weather cleared, and ca. 20 readily identifiable individuals of *C. ebenina* of both sexes were seen. Also found in the general vicinity were *Pyrgus centaurae*, *Colias philodice*, *Vanessa (Cynthia) virginicensis*, *Papilio* spp., *Strymon melinus*, *Panhiades m-album*, and *Callophrys henrici*. Skippers of the genus *Erynnis* (especially *E. juvenalis*) were abundant everywhere along roadsides. *Celastrina pseudargiolus* was common throughout the area, both in woodlands and along roadsides, where the males were clustered on moist earth.

Celastrina ebenina was confined strictly to the tiny valley site described by Clench with only one exception. A solitary male was "mudding" with far more numerous *C. pseudargiolus* ca. ¼ mile away along a dirt road. Recognition of females in the field is somewhat difficult, but the blue color has a grayish-green cast, and the flight pattern may be different (see below). A few specimens were taken, but most of the butterflies were only observed.

Males are much less conspicuous on the wing than males of *C. pseudargiolus* because they lack the blue reflectance. We found males of *C. ebenina* difficult to detect and follow in flight except in unusually good circumstances. Both sexes flew lower and faster than *C. pseudargiolus*. This was observed especially well in the open areas of the habitat. The males tended to have a direct, swift flight within one foot of the ground vegetation, with much "exploring." *Celastrina pseudargiolus* generally flew slower, rather fluttery, more up and down flight, and usually in the upper shrub layer.

No actual instances of *C. ebenina* feeding on flowers were observed, but several males hovered around Jacob's ladder (*Polemonium reptans*) flowers and stemless

blue violets (*Viola* cf. *cucullata*). One male landed on the petal of a Cranesbill flower (*Geranium maculatum*).

Egg-lying was not observed, and thus no information on potential larval foods was obtained. Every plant species we saw both in and out of the small valley was common and widespread. It is possible that foodplants are various and that the limiting factor in local distribution involves something special about the habitat. Certainly the confinement of the Zaleski population to its little valley is extraordinary. We searched in many gulleys and woodlands in the region but found no additional populations, which indicates that other populations, if present, are very scattered.

The Zaleski habitat is difficult to assess botanically because the north-facing slope has a very different flora from the one facing south. The north-facing slope has a maple-basswood association. Such rich woodland forbs as species of *Viola*, *Dicentra*, *Orchis*, and *Trillium* are prominent. The south-facing slope is much more exposed and dry, and it has an oak-hickory association. Fewer forbs occur at ground level, and there is a strong development of ericads. The center of the *C. ebenina* habitat is a cool, moist opening, just below a rocky waterfall. Here the dominant plant is spicebush, *Lindera benzoin*. If *C. ebenina* originates in the adjacent woods, we are inclined to associate the species with the north-facing slope. We actually saw a few specimens ca. 50' above the bottom of the valley on that slope, and most of the specimens arriving below the waterfall came from that side.

There is some question about how far west *C. ebenina* occurs. Until recently, the Zaleski site was the farthest west of thoroughly documented localities. Clench (1972) reports the species far to the northwest in Wabash Co., Indiana. In 1972, David K. Parshall (pers. comm.) encountered a small colony in the Fort Hills State Park in Highland Co., Ohio, southeast of Hillsboro. This is over 50 miles to the west of the Zaleski site and is the second record for Ohio. Parshall informed us that the butterfly is "intensely local" and seems to appear "a little later than *C. pseudargiolus*." His locality, along with the two in Kentucky described below, represent the western extent of *C. ebenina* based upon actual specimens.

We herewith report *C. ebenina* for the first time from Kentucky. On 21 April 1974, Gerald B. Straley and Wagner visited a richly wooded area along Rt. 77 in Menifee Co. ca. ½ mile north of the Menifee-Powell line, where the following butterflies were flying: *Amblyscirtes vialis*, *Erynnis juvenalis*, *E. icelus*, *Epigyreus clarus*, *Everes comyntas*, and *Pieris virginianensis*. Among the blues collected by Straley, one was later identified as a female *C. ebenina*.

In Breathitt Co. near Elkatawa, Showalter took a single female *C. ebenina* on the wing on 26 April 1975. In Menifee Co. near the junction of Rt. 77 and the Powell Co. line, close to where Straley found the species, two males were taken on mud on 27 April 1975.

From the evidence so far, the species appears to be closely associated with more or less mature, rich, deciduous forest. The general impression is that this scarce butterfly is most often encountered singly or in groups of a few individuals. Sizable populations are unusual, as is the case with such other lycaenids in the eastern United States as *Erora laeta* and *Euristrymon ontario*. Price (1974 J. Lepid. Soc. 28: 268) found *C. ebenina* several times in Buncombe Co., North Carolina, but observed only one or two individuals at a time. S. S. Nicolay (*in litt.*), however, saw the species in considerable numbers during the early 1950s in Pendleton Co., West Virginia.

We should like to recommend that care be taken to preserve the natural populations of *C. ebenina*. A better pursuit than merely making large collections of them would be to observe the insect and learn more of its habitat, larval food, and adult behavior, especially in comparison with the ever-present *C. pseudargiolus*, with which it was so long confused.

We wish to acknowledge the help of Harry K. Clench, John Evans, Donald J.

Harvey, S. S. Nicolay, David K. Parshall, Gerald B. Straley, and Florence S. Wagner in making this study.

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A MIGRATION OF *VANESSA CARDUI* (NYMPHALIDAE)

Recently, in arranging a 25 year collection of Manitoba butterflies, a short series of eight specimens of *Vanessa cardui* (Linnaeus) was located in the writer's collection. Two are dated 4 June 1952; five are dated 5 June 1952 and one is dated 7 June 1952. These are small specimens as compared to locally emerged autumn specimens.

The above eight specimens (a ninth has just been found in the Sam Waller Museum at The Pas from the same series and collection dates) were netted from among dozens that were flying at shoulder height from the east into the northwest. This is against the prevailing winds in this part of Canada.

The migration started on the first of June 1952 and continued for the next seven days. The flight was a light one and the specimens are in remarkably good condition. The flight went through the eastern part of the town of four thousand people. One of two butterflies could be seen crossing a town block at any one time. They would also come in spurts of three or four and then there would be pauses when none would be seen. The flight was most pronounced at about 1600 hours. The butterflies then flew lower and into the setting sun. The flight ended at the end of the week as suddenly as it had started.

Vanessa cardui cannot survive our severe winters this far north in Canada. The autumn generation here is produced from spring migrants. In some years not one *V. cardui* is seen all summer. Those that are locally produced in August are very large and brilliantly marked.

The migration of 1962 was of continental dimensions and reached The Pas. It was locally abundant and coincided with the blooming of the dandelions in the first week of June. In this regard it resembled the 1952 local flight.

There is, however, a vast difference between specimens of the two flights separated by a 10-year period. In the 1952 flight the specimens were small, well marked and fresh looking. Specimens of the 1962 flight were large, much worn and tattered and were in greater numbers than the 1952 flight. In 1962 almost every dandelion had its butterfly. No directional flight was noted. They suddenly appeared in vast numbers in The Pas area and gradually became more and more tattered. The flight died out naturally here, not moving elsewhere. The local autumn flight is at best a small one in most years. There are not as many thistles around as there were in the 1950's. The use of herbicides along roadsides possibly accounts for this. A day's collecting in the fall produces a few specimens of *Vanessa cardui* in the best of years.

The 1952 June migration, strangely enough, did not produce a large autumn flight. This was expected and proved a disappointment when it failed to materialize.

It is probable that the remarkable heat wave, breaking all previous records, on 19 April 1952, influenced insect movements locally. At The Pas the heat persisted for three days, "bringing out" many species of noctuid moths in large numbers. Rare species appeared in numbers that have not been taken since.

The temperature rose to 80°F...producing a sultry night. This is unheard of in these parts in April. It resembled an August night before a storm! These weather conditions may have initiated the *Vanessa cardui* migration some weeks later.

WALTER V. KRIVDA, *P.O. Box 864, The Pas, Manitoba, Canada.*

BOOK REVIEW

MACROLEPIDOPTERA OF FIJI AND ROTUMA: A TAXONOMIC AND BIOGEOGRAPHIC STUDY, by Gaden S. Robinson. 1975. E. W. Classey Ltd, Park Road, Faringdon, Oxon, Great Britain. vii + 362 p., 357 plate figures, 173 text figures, 15 maps. Price \$25.95 (U.S.).

The base data for the biogeographic study are 400 species of macrolepidoptera of Fiji and Rotuma. These are treated in an abbreviated manner with the citation of the original description, whether type specimen was examined (usually indicated), description of male and female, diagnosis, world distribution, Fijian distribution, biology (if known) and remarks for each species. Keys for some of the larger genera are given. Each species is illustrated by a half-tone of the adult and some by diagnostic line drawings of the genitalia. Two genera, 72 species and 10 subspecies are newly described. Most of the more than 1 million specimens were collected by G. and H. S. Robinson between 1966 and 1972. Additionally, material accumulated by nearly all earlier collectors was studied.

Robinson uses cluster analysis of the accumulated data to define groups of species with common distribution patterns for combinations of islands and then generalizes from them. To compare the faunas of many Pacific islands he subdivides the macrolepidoptera into: a) generally large, strong flying moths, b) generally smaller, weaker flying moths than in group a, and c) butterflies. Major conclusions are: 1. Fiji has an unusually high percentage of endemic species, 46% (182 species) and is second only to the Hawaiian Islands among the Pacific islands in species endemism. 2. The largest number of Fijian endemic species are associated with the rain forest. 3. Fiji has an island fauna that is derived mainly from the New Hebrides, Solomons and Papuaia. 4. Species common to Fiji and many Pacific islands are associated with secondary vegetation and are mainly those that can colonize "weedy" areas. 5. One gateway to Polynesia was from the southern Solomon Islands via Rotuma and several other islands to Samoa during periods of maximum glaciation. 6. The butterfly fauna of Fiji is relatively impoverished. 7. Rotuma has a low percentage, 8% (6 species), of endemic species.

This book is a major contribution to our knowledge of the biogeography of the Pacific islands and to the knowledge of the macrolepidoptera of Fiji and Rotuma. It is well documented. Some minor points of criticism are: I seriously doubt that those species for which the type specimens were not examined are unquestionably correctly identified; I presume that an editorial decision caused Hübner to be spelled "Hubner" and Guenée to be spelled "Guenée"; and for ease of reference, numbering each page throughout the work would have been helpful.

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STUDIES ON THE *CATOCALA* (NOCTUIDAE) OF SOUTHERN NEW ENGLAND. V. THE RECORDS OF SIDNEY A. HESSEL FROM WASHINGTON, CONNECTICUT, 1961-1973

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With the death of Sidney A. Hessel on 11 November 1974, lepidopterists lost one of their most enthusiastic and inspiring colleagues. This sad event also closed the pages on an unprecedented compilation of records on the moths of a single genus at a single location, for Hessel had faithfully noted all of the *Catocala* specimens taken at two light sources near his home on virtually every night of 12 seasons between 1961 and 1973.

These records, portions of which have been previously published (Sargent & Hessel, 1970; Sargent, 1976), are summarized and analyzed here, particularly with a view to assessing (1) the variability in *Catocala* populations from year to year, (2) the extent of seasonal separation among the various species, and (3) the degree of stability in hindwing diversity across seasons. I also hope to demonstrate the usefulness of such records for the development and testing of hypotheses relating to the ecology of these moths. Specifically, I will propose a mechanism for the maintenance of stability in the frequencies of certain hindwing patterns, drawing upon applicable data from Hessel's records.

I hope that this paper will illustrate the value of complete and detailed records that extend over several seasons and thus will encourage others to gather similar data at their own locations.

METHODS

Washington is located in the Litchfield Hills of west-central Connecticut. The collecting site itself was at the bottom of a narrow north-south valley through which an all-season stream flowed southward. The

TABLE 1. Numbers of individuals (N) of all *Catocala* species taken over 12 seasons (1961-65, 1967-73) at Washington, Connecticut and the corresponding percentages (%) of the *Catocala* sample.

Species	N	%	Species	N	%
<i>palaeogama</i>	1795	17.45	<i>cara</i>	82	0.80
<i>residua</i>	1217	11.83	<i>ilia</i>	67	0.65
<i>habilis</i>	964	9.37	<i>crataegi</i>	47	0.46
<i>amica</i>	790	7.68	<i>defecta</i>	46	0.45
<i>concupens</i>	676	6.57	<i>parta</i>	45	0.44
<i>ultronia</i>	632	6.14	<i>subnata</i>	44	0.43
<i>grynea</i>	466	4.53	<i>unijuga</i>	42	0.41
<i>neogama</i>	446	4.34	<i>flebilis</i>	40	0.39
<i>antinympa</i>	441	4.29	<i>blandula</i>	40	0.39
<i>relecta</i>	403	3.92	<i>coccinata</i>	39	0.38
<i>serena</i>	353	3.43	<i>praeclara</i>	38	0.37
<i>epione</i>	264	2.57	<i>relecta</i>	23	0.22
<i>obscura</i>	224	2.18	<i>similis</i>	21	0.20
<i>andromedae</i>	212	2.06	<i>amatrix</i>	7	0.07
<i>judith</i>	211	2.05	<i>innubens</i>	6	0.06
<i>mira</i>	201	1.95	<i>briseis</i>	3	0.03
<i>micronympha</i>	159	1.55	<i>piatrix</i>	1	0.01
<i>badia</i>	127	1.23	<i>vidua</i>	1	0.01
<i>gracilis</i>	114	1.11	<i>cerogama</i>	1	0.01

site was surrounded by hills, mostly of mixed deciduous woodlands, but including patches of earlier seral stages that result from the periodic establishment and abandonment of farms and pastures.

Most of the moths were obtained in a Robinson mercury vapor light-trap that was operated from dusk to dawn. The contents of this trap were checked each morning, and the number of specimens of each *Catocala* species was recorded. The majority of the specimens was released near the trap location after examination, so some individuals may have been captured and recorded on more than one occasion. However, studies of color-marked *Catocala* have shown that very few specimens are recaptured under such circumstances (Sargent, 1976). A few records were obtained at a 15-watt fluorescent black-light, which was checked periodically during the evening, and these records were combined with the Robinson trap data in Hessel's daily compilations. Both light sources were in operation from mid-March to mid-November each year (except for occasional 1-3 day absences).

The species of *Catocala* were identified as keyed and described in Forbes (1954), except that *gracilis* and *sordida* were not always distinguished; these species are considered together (as *gracilis*) throughout the present report.

A total of 10,288 *Catocala* specimens of 38 species was recorded over

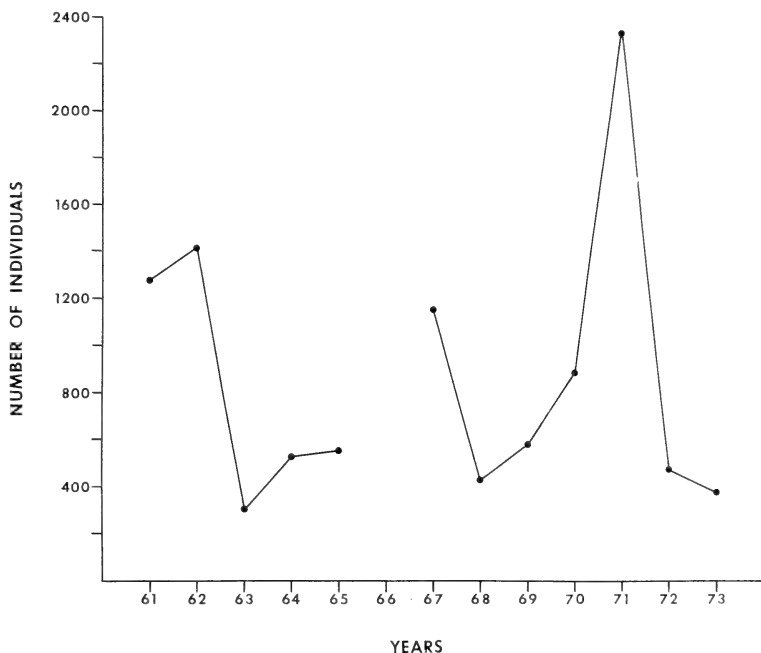


Fig. 1. Total number of *Catocala* taken each year at two light sources at Washington, Connecticut.

the 12 seasons, 1961–65 and 1967–73. The numbers of each species taken, ranked in decreasing order of abundance over the 12 seasons, are given in Table 1.

RESULTS AND DISCUSSION

Annual Variations

Analysis of Hessel's records revealed considerable variation in the *Catocala* samples from year to year, despite essentially identical collecting procedures. These variations included changes in (1) the total abundance of all *Catocala*, (2) the relative abundance of particular species, and (3) the overall pattern of species abundance.

The size of the *Catocala* sample fluctuated markedly from year to year, ranging from a low of 306 specimens in 1963 to a high of 2337 specimens in 1971 (Fig. 1). No long-range trend of increasing or decreasing *Catocala* abundance could be discerned against the erratic fluctuations in annual abundance.

In addition to changes in total abundance, there was also considerable

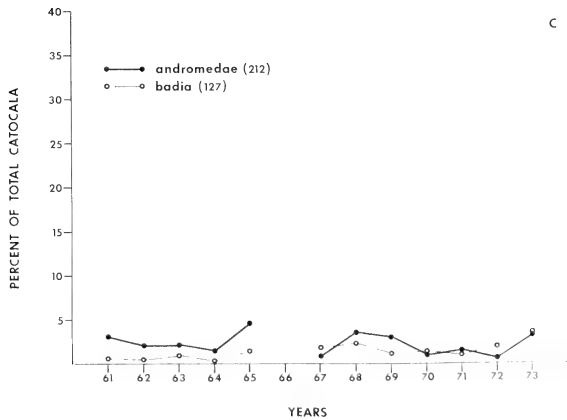
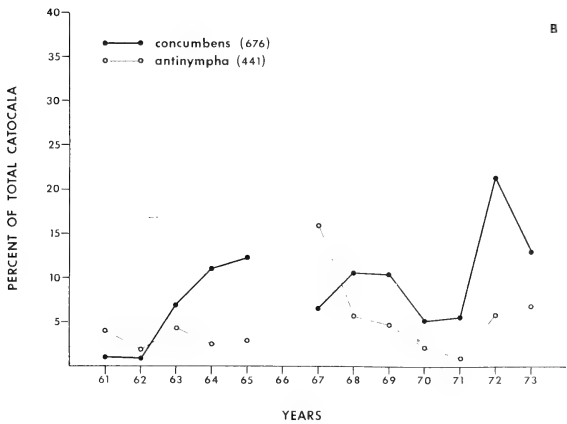
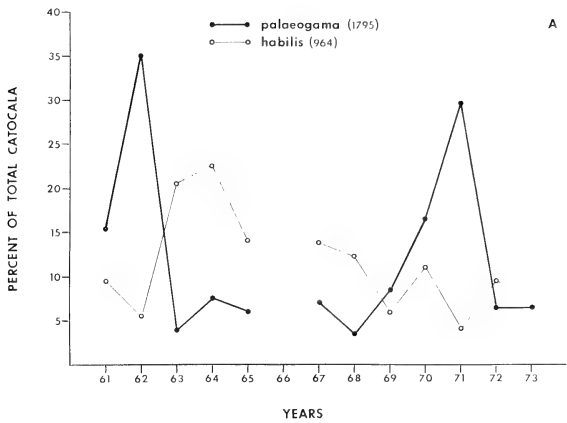
TABLE 2. The highest and lowest annual totals, with the corresponding percentages of total *Catocala* taken, for those species having at least 100 records over 12 seasons at Washington, Connecticut.

Species	Annual Totals			
	High		Low	
	N	%	N	%
<i>palaeogama</i>	690	29.53	12	3.92
<i>residua</i>	345	24.43	7	1.89
<i>habilis</i>	159	13.81	23	6.22
<i>amica</i>	281	12.02	10	3.27
<i>concumbens</i>	130	5.56	12	0.85
<i>ultronia</i>	220	9.41	14	4.58
<i>grynea</i>	72	5.65	8	2.61
<i>neogama</i>	97	7.61	4	0.86
<i>antinympa</i>	182	15.81	13	2.45
<i>resecta</i>	83	6.51	9	2.43
<i>serena</i>	124	5.31	0	—
<i>epione</i>	69	5.41	5	1.07
<i>obscura</i>	28	1.20	3	0.98
<i>andromedae</i>	40	3.14	3	0.64
<i>judith</i>	95	4.07	0	—
<i>mira</i>	76	3.25	2	0.17
<i>micronympha</i>	43	3.05	1	0.21
<i>badia</i>	27	1.16	2	0.38

variation in the relative abundance of particular species from year to year. The highest and lowest annual totals of those species for which there were at least 100 records over the 12 years of collecting are given in Table 2. These data suggest that the more common species in the overall totals were more erratic in terms of annual abundance than were the less common species. This suggestion is supported by comparisons of the relative annual frequencies of certain more and less common species (Fig. 2). It is apparent that the most abundant species overall exhibited explosive increases in numbers from time to time, whereas the less common species maintained rather constant frequencies over the years. These differences in relative abundance across years suggest differences in the mechanisms by which populations of various species are regulated, and this possibility certainly warrants further study.

The 12-year totals of the *Catocala* species from this location (Table 1)

Fig. 2. Fluctuations in abundance from year to year of several *Catocala* species at Washington, Connecticut. Abundance is expressed as a percentage of the total *Catocala* recorded each year. The species considered range in status from abundant (A) to common (B) to uncommon (C).



reveal a distribution of species abundance that is characteristic of most field samples of this sort, i.e., a few very common and many uncommon species. In this case, the five most common species comprised over 50% of the records, whereas the 20 most uncommon species comprised less than 7% of the total sample. However, the extent to which this pattern was developed did vary from year to year. For example, the most common species in 1962 (*palaeogama*) comprised 35% of the sample for that year, but the most common species in 1969 (*concumbens*) comprised only 10% of the sample. At the other extreme, 15 species were recorded fewer than five times in 1963 (nine species occurred only once), whereas only six species were recorded fewer than five times in 1962 (only one species occurred only once).

These examples of annual variation in samples from a single location should illustrate the futility of making long-term assessments of *Catocala* populations on the basis of limited collecting. For even these records of Hessel, as extensive and complete as any known for the *Catocala*, will permit few conclusions regarding the status, or trends in the status, of the species at his location. This finding, however, is perhaps one of the most valuable to emerge from his records. As I have said elsewhere (Sargent, 1976), "Perhaps the lesson here is to view most general assessments of status in the *Catocala* as tentative."

Seasonal Occurrence

One of the most interesting questions regarding the *Catocala* concerns the nature of the isolating mechanisms that prevent hybridization among the many species which occur together at any one place. This problem has been discussed in detail elsewhere (Sargent, 1976), and it seems likely that many factors coact to isolate the various sympatric species. These factors include differences in daily and seasonal activity periods, and in courtship and mating behaviors. Here we will be concerned with only one of these factors—differences in seasonal occurrence.

Hessel's daily records, which cover the entire *Catocala* season for many years, are particularly useful for analyses of such differences; for his records, especially when summed across the years, provide the large sample sizes essential for the detection of relatively small seasonal offsets.

Hessel took adult *Catocala* over a four-month period (July–October), but most of his records fell between mid-July and mid-September (Fig. 3). A total of 33 species was taken during the second half of August, and as many as 21 species were recorded on a single night during that period (Sargent & Hessel, 1970). Clearly, many species had overlapping flight seasons.

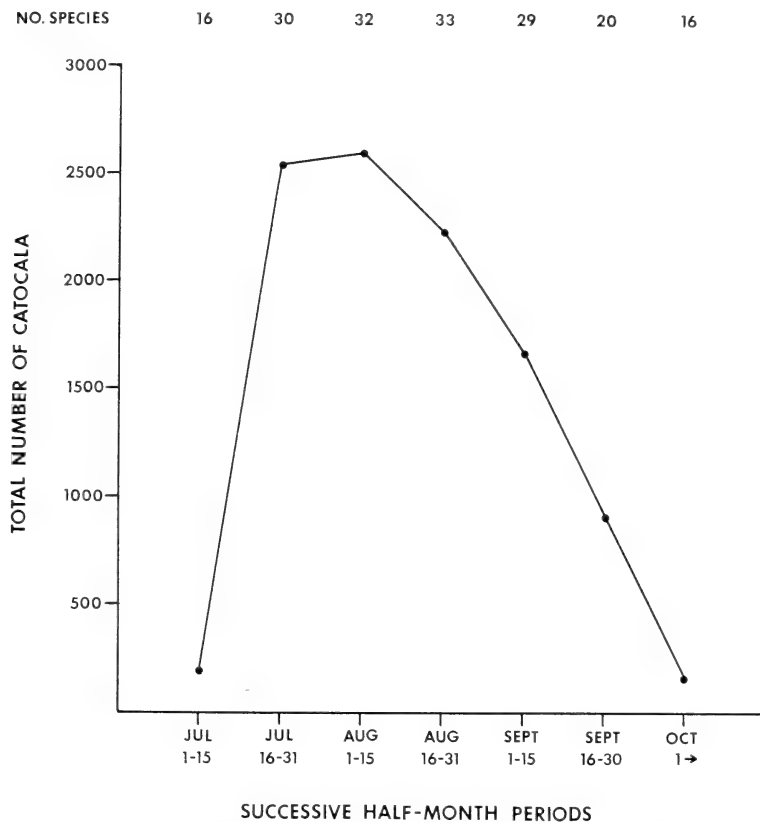


Fig. 3. The total number of *Catocala* recorded during successive half-month periods of the season at Washington, Connecticut, summed over 12 years. The number of species taken during each half-month period is given at the top of the graph.

However, if one compares the median dates of capture of those species for which there were 24 or more records (Fig. 4), some interesting seasonal offsets between certain species become apparent. Thus, for example, approximately a month separates the median dates of capture of *dejecta* (3 August) and *resecta* (2 September), and *serena* (11 August) and *habilis* (14 September). In these cases, three-quarters of the records of the earlier species occurred before the first quarter of records for the later species. Other closely related species pairs exhibiting marked differences in median capture dates include *blandula* (13 July) and *mira* (1 August), *subnata* (10 August) and *neogama* (6 September), *residua* (19 August) and *obscura* (6 September), and *concupiens* (25 August)

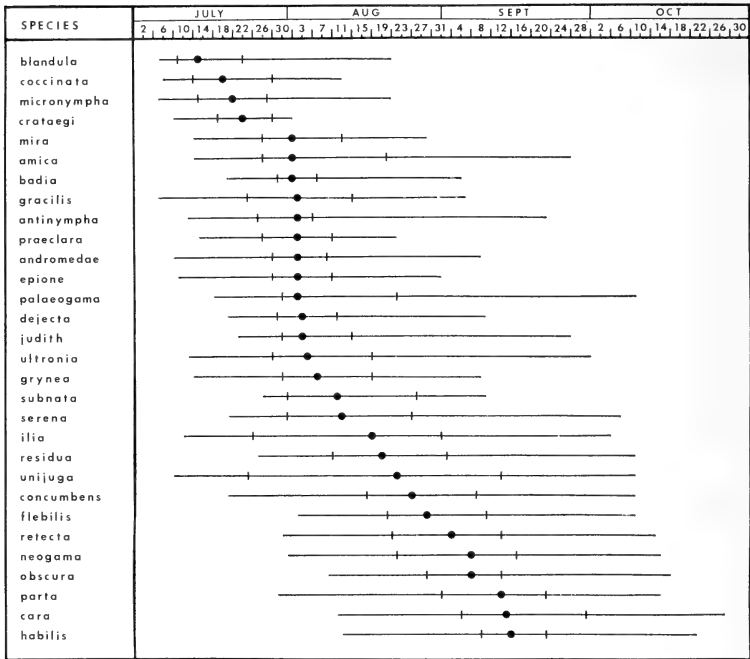


Fig. 4. Seasonal occurrence of *Catocala* species at Washington, Connecticut based on records summed over 12 seasons. The lines run from the earliest to the latest dates of capture, and quartile dates are indicated by a dot (median) and dashes (first quarter, third quarter). Only species for which there were 24 or more records are considered, and these are arranged in descending order on the basis of a seasonal sequence from early to late.

and *cara* (13 September). Assuming that most matings occur near the beginning of the flight season of a species, it seems likely that seasonal offsets such as these must contribute to the reproductive isolation of the species involved.

On the other hand, certain other pairs of closely related species had nearly identical median dates of capture. Among such pairs were *badia* (1 August) and *antinympha* (2 August), *gracilis* (2 August) and *andromedae* (2 August), and *praeclara* (2 August) and *grynea* (6 August). Clearly such species pairs must depend on isolating mechanisms other than seasonal separation.

Complete understanding of the complex of factors that isolate all of the *Catocala* species at any one location must await much more study. But these records of Hessel suggest that seasonal separation is one of the factors involved in certain cases.

TABLE 3. Distribution of *Catocala* in five hindwing groups at Washington, Connecticut (1961-65, 1967-73).

Hindwing Group	Species	Number	%
1	<i>relicta</i>	23	0.22
2	<i>epione</i> , <i>judith</i> , <i>flebilis</i> , <i>obscura</i> , <i>residua</i> , <i>relecta</i> , <i>dejecta</i> , <i>vidua</i> , <i>andromedae</i>	2618	25.45
3	<i>piatrix</i> , <i>antinympa</i> , <i>badia</i> , <i>habilis</i> , <i>serena</i> , <i>palaeogama</i> , <i>subnata</i> , <i>neogama</i> , <i>cerogama</i> , <i>gracilis</i> , <i>crataegi</i> , <i>mira</i> , <i>blandula</i> , <i>grynea</i> , <i>praeclara</i> , <i>similis</i> , <i>micronympha</i> , <i>amica</i>	6048	58.79
4	<i>innubens</i> , <i>ilia</i> , <i>parta</i> , <i>briseis</i> , <i>unijuga</i> , <i>coccinata</i> , <i>ultronia</i>	834	8.11
5	<i>cara</i> , <i>concumbens</i> , <i>amatrix</i>	765	7.44

Hindwing Diversity

The forewings of many *Catocala* species are strikingly variable (polymorphic), but the hindwings are essentially invariable (monomorphic) within any species. However, hindwing diversity across species is substantial, and this matter has been the subject of considerable prior study (Sargent, 1969, 1973, 1976; Sargent & Owen, 1975). The records of Hessel provide an opportunity to analyze the occurrence of various hindwing types at a single location in considerable detail. This analysis in turn prompts some speculation regarding the apparent maintenance of stability in hindwing diversity at this location.

Dr. Denis Owen and I recently analyzed the frequencies of various hindwing types occurring in large *Catocala* samples taken at mercury vapor lights at four localities in eastern North America (Sargent & Owen, 1975). For purposes of our analysis, the hindwing patterns were arbitrarily divided into five groups: (1) black and white, banded; (2) black, unbanded (on upper surface); (3) yellow to yellow-orange and black, banded; (4) orange-red to red and black, banded; and (5) pink and black, banded. The frequency distribution of these hindwing types was remarkably similar at each of the localities we considered, despite marked differences in species composition. These frequencies closely resembled those obtained at Washington, Connecticut, as compiled from Hessel's total records (Table 3).

This apparent stability in hindwing diversity at different locations was more simply expressed by combining the hindwing groups into an achromatic assemblage (groups 1 and 2) and a chromatic assemblage (groups 3, 4, and 5). This division emphasizes the most obvious hindwing dichotomy in the *Catocala*, i.e., the presence or absence of color. And the

frequency of occurrence of these two hindwing types was nearly constant across localities, with achromatic individuals consistently comprising ca. 20% of the total *Catocala* samples (Sargent & Owen, 1975).

We interpreted the apparent stability in hindwing diversity at various locations as a result of selective predation, especially by birds, and argued that the observed frequencies function to "confuse" predators, presumably by introducing the element of anomaly (the unexpected) into the overall predator-prey system (Sargent & Owen, 1975). Thus, for example, achromatic hindwings might serve as effective startle devices only if they comprised no more than ca. 20% of the total *Catocala* hindwings encountered. At higher frequencies, predators might come to expect such a hindwing pattern, and predation would increase until the frequency was again returned to 20% of the total. Presumably, such selection pressure would eventually result in stabilization of the different hindwing types at optimal frequencies with respect to predation.

In further analyzing Hessel's records, I will consider only the achromatic and chromatic hindwing groups, since these are the most easily defined and perhaps most meaningful categories with respect to *Catocala* hindwing diversity. And since most of the species with achromatic hindwings feed as larvae on the Juglandaceae (hickories, *Carya*, and walnuts, *Juglans*), particular attention will be devoted to the species that utilize those foodplants.

The percentage of specimens with achromatic hindwings at Washington, Connecticut ranged from 16.76% in 1973 to 36.24% in 1961 and averaged 25.67% over the 12 years. However, a more striking constancy of achromatic hindwings can be demonstrated when only those *Catocala* whose larvae feed on the Juglandaceae are considered. This analysis excludes only two achromatic species from Hessel's totals (*relicta*, a Salicaceae feeder; and *andromedae*, an Ericaceae feeder), leaving eight achromatic (*epione*, *judith*, *flebilis*, *obscura*, *residua*, *retracta*, *dejecta*, and *vidua*) and six chromatic species (*piatrix*, *habilis*, *serena*, *palaeogama*, *subnata*, and *neogama*). All of the chromatic species in this case have yellow-orange and black, banded hindwings.

The percentage of individuals with achromatic hindwings among these Juglandaceae-feeding *Catocala* was remarkably constant from year to year, despite considerable variation in the species composition and the number of individuals taken each year (Fig. 5). Such stability in the occurrence of achromatic hindwings suggests the operation of a control mechanism related in some way to predation.

Two possibilities immediately come to mind: (1) predators consistently select *Catocala* such that trapped samples will reveal a constant

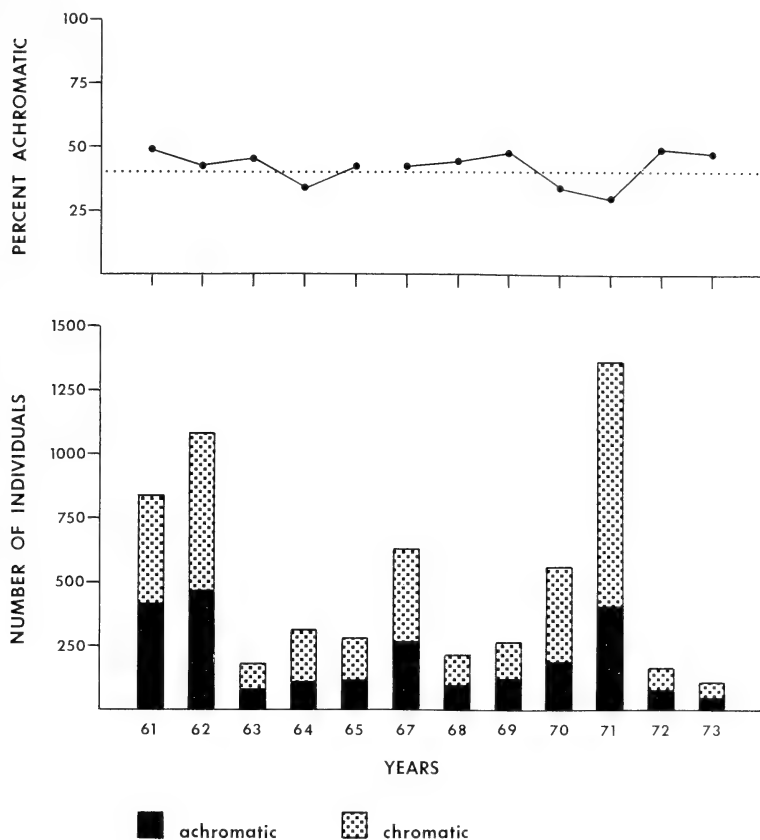
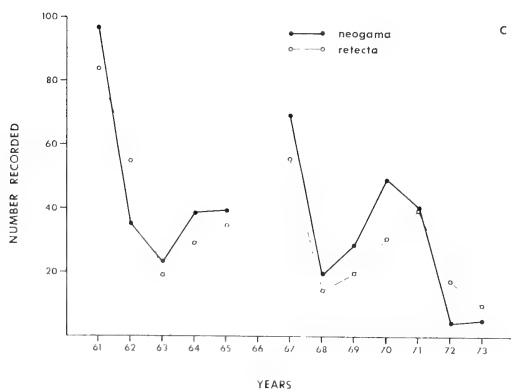
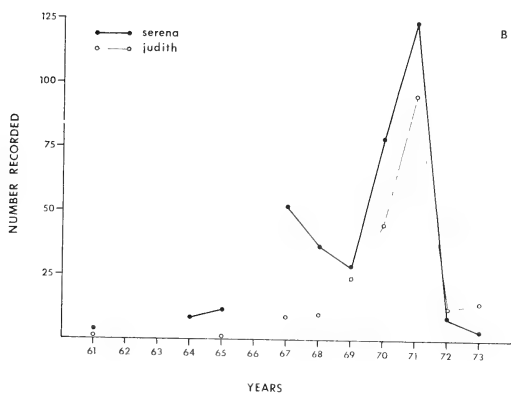
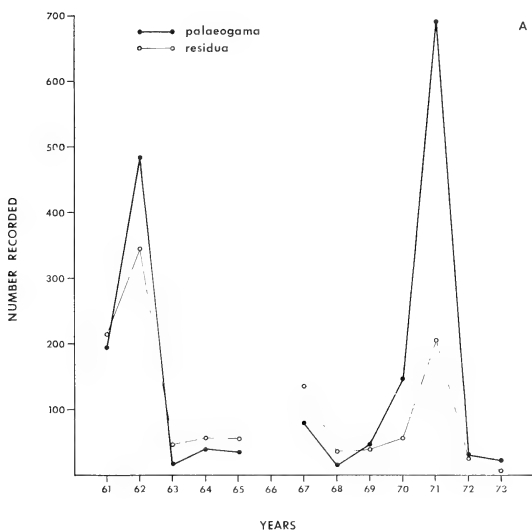


Fig. 5. Number of Juglandaceae-feeding *Catocala* taken each year at Washington, Connecticut with achromatic and chromatic hindwings distinguished (bottom); and the corresponding percentages of individuals with achromatic hindwings (top).

frequency of achromatic hindwings; and (2) the moths themselves, in response to long-term predator selection, have evolved the means of maintaining a constant frequency of achromatic hindwings. Both possibilities pose difficulties, but it seems particularly unlikely that the stability of achromatic hindwings in trapped samples is entirely a product of immediate predator selection; for this would assume that few moths are trapped prior to their exposure to intense predator selection, and such an assumption seems clearly unreasonable.

Thus, the possibility that the moths themselves are maintaining a constant frequency of achromatic hindwings must be examined. This possibility is rendered particularly perplexing in view of the fact that



none of the species involved are polymorphic with respect to hindwing types, and, consequently, mechanisms that would maintain a balanced polymorphism within a species (Ford, 1964) cannot be operating. How, then, is a stable relationship between two hindwing types to be achieved in a complex of species, each monomorphic with respect to hindwing type, and each highly variable with respect to abundance from year to year?

One theoretical possibility in a system wherein each species regulates its own density by assessing and responding to the density of every other species present. Such density regulation might be envisioned for a single species (Wynne-Edwards, 1962) but seems entirely implausible for an assemblage of species, given the complex social behaviors required in such a control system.

It may be, however, that an overall stability in the relationship between achromatic and chromatic hindwings could be achieved on the basis of simpler interactions between or among certain species. If, for example, the achromatic and chromatic species were paired and the members of each pair exhibited parallel fluctuations in annual abundance, then a stable relationship between the two hindwing types would result.

That such pairings of species may exist is suggested by the nearly identical fluctuations in annual abundance of certain achromatic and chromatic species (Fig. 6). These similarities suggest that the two species involved in each case are responding to environmental variables in the same fashion and thus may have identical, or nearly identical, ecological niches. This suggestion, however, seems to raise problems with respect to the so-called *competitive exclusion principle*, i.e., the ecological dictum that two species cannot share the same niche, since competition between them should eventually exclude the less well-adapted species (see discussion in any ecology text, e.g., Ricklefs, 1973). This principle clearly assumes that the two species compete for some limiting resource, usually food. The *Catocala*, however, may be limited by predation rather than the availability of food, and in that case the competitive exclusion principle would not apply.

The fact that many *Catocala* species may utilize the same hostplant suggests that food is not generally limiting for these moths. Many of the

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Fig. 6. Numbers of individuals of three pairs of Juglandaceae-feeding *Catocala* species taken each year at Washington, Connecticut. The species are paired on the basis of similarities in abundance across years, and each pair includes a species with achromatic hindwings (open dots) and a species with chromatic hindwings (solid dots).

Juglandaceae feeders under consideration here, for example, are known to feed on shagbark hickory (*Carya ovata*) (Sargent, 1976). On the other hand, the fact that the ova, larvae, and adults of most *Catocala* are highly cryptic implies that predation has long been substantial on these insects. There is some evidence for heavy bird predation on the adults, since beak-damaged individuals may comprise as much as 4% of trapped specimens (Sargent, 1973). Such beak-damaged individuals have escaped from their predators, but presumably many more individuals are actually eaten by birds. I have shown that naive blue jays (*Cyanocitta cristata* (L.)) will quickly learn to capture *Catocala*, rarely losing individuals after 12–15 experiences with these moths (Sargent, 1973).

It seems likely that the simultaneous presence of two species with different hindwing types would be advantageous to both species with respect to the effectiveness of their hindwings as startle devices, for birds are clearly less effective predators when confronted with the novel or unexpected in their prey (Sargent, 1976). And since novelty and anomaly are functions of scarcity, the advantage of any one hindwing type should increase as the numbers of the other hindwing type increase.

Thus, it follows that two species with different types of hindwings might share the same niche, and the advantage of each species with respect to predation would increase as the other species increased in abundance. In such a situation, neither species should act to exclude the other from the niche, and each should become as abundant as other limitations (climate, parasites, etc.) permit. Given that the two species are closely related and are adapting to the same niche, it should not be surprising to find them occurring in approximately equal numbers, as seems to be the case in several instances at Washington, Connecticut (Fig. 6).

The system envisioned here would result in stable relationships between pairs of species with achromatic and chromatic hindwings and would not require intrinsic mechanisms for the assessment or adjustment of population densities. One species would need only to adapt to a niche already occupied by a species with a different type of hindwing. If such pairs of species comprised a substantial portion of the total of species under consideration, then a stable overall relationship between the different hindwing frequencies would be expected.

There remains the question of why hindwing diversity, if it is such an advantage with respect to predation, has not developed *within* any species. The answer must be that there is an even greater advantage associated with hindwing monomorphism at the species level. This suggests that the hindwings function as specific recognition devices, per-

haps serving as releasers during courtship and mating behaviors, and thus act to isolate various species. If the hindwings do serve as isolating mechanisms, it seems possible that sympatric speciation on the basis of hindwing differentiation might occur on occasion in the *Catocala*. Sympatric speciation might then account for the phenological similarities we have seen in certain pairs of species with different types of hindwings.

These ideas regarding the maintenance of stability in hindwing diversity, though often quite speculative, are based on data that Hessel acquired over many years at Washington, Connecticut. I hope that other workers will be stimulated to test these ideas by acquiring additional data and conducting further studies on the *Catocala* at their locations. Whether such studies support or refute the ideas developed here, the results can only advance our understanding of these moths. And in this way, the records of Hessel will make their most important contribution.

SUMMARY

The late Sidney A. Hessel of Washington, Connecticut recorded all of the *Catocala* taken at two light sources near his home over 12 seasons (1961-65, 1967-73). Totals of 38 species and 10,288 individuals were recorded.

The *Catocala* populations at this location varied considerably from year to year. These annual variations included changes in the total number of *Catocala* taken, the relative abundance of particular species, and the overall pattern of species abundance. The more common species exhibited more erratic fluctuations in annual abundance than the less common species. It is concluded that limited collecting will not permit long-term assessments of status and trends in *Catocala* populations.

The *Catocala* season at Washington extended from July-October, and most of the species had overlapping flight seasons. However, detailed analyses, including comparisons of the median dates of capture of various species, suggested that certain closely related species might be isolated in part by seasonal offsets.

The frequency distribution of various hindwing types at Washington is summarized. The percentage of individuals with achromatic hindwings, particularly within the group of Juglandaceae-feeding species, remained remarkably stable over the years. A possible mechanism for the maintenance of that stability is proposed, based on observations of nearly identical fluctuations in annual abundance of certain pairs of species that included one member with achromatic hindwings and one

member with chromatic hindwings. It is suggested that the species in each of these pairs may share the same ecological niche, and may have arisen sympatrically.

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MELITAEA SAXATILIS MOD. "SASSANIDES" (NYMPHALIDAE) IN IRAN: CONFIRMATION OF AN OLD RECORD

On 5 July 1974 I took eight adult specimens of *Melitaea saxatilis* mod. "sassanides" (Higgins) in Alborz, Mount Damavand, northern Iran. The butterfly was restricted to the height of 4000 m, near the third mountaineer's shelter where a steep rock slope was covered by a few scattered species of Cruciferae, Labiatae and grasses. The adults were feeding on the few Labiatae flowers that existed. No early stages were found.

Higgins (1941) in his "An illustrated catalogue of the Palearctic *Melitaea*" (Trans. Roy. Ent. Soc. London 91: 175-365) mentioned that the only specimens he saw were amongst the ex. coll. Grun-Grshimaile collection at the British Museum. They were collected on 29 June 1894 and no additional record has ever been published. Personal contact with Dr. Higgins and the literature confirm this claim. Unfortunately, due to the change of the weather and the dangerous location of the butterfly habitat, I was not able to collect a sample of the vegetation or investigate farther.

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DISTRIBUTION AND BIOLOGY OF A PLEISTOCENE RELICT:
OCHLODES YUMA (HESPERIIDAE)JAMES A. SCOTT¹, OAKLEY SHIELDS², AND SCOTT L. ELLIS³

The purpose of this paper is to summarize our knowledge of the distribution, life history and behavior of *Ochlodes yuma* (Edwards), a little-known western United States skipper.

Larval foodplant. *Phragmites communis* Trin., the Common Reed, is a large (ca. 2 m), cosmopolitan, perennial grass forming canelike thickets in wet places, with a wind-dispersed fruit and spreading rhizome (Mason, 1957; Polunin, 1960, p. 98). It occurs in Europe, Asia, Africa, the Americas, and Australia but is absent from many islands (Ridley, 1923). It may be the most widely distributed flowering plant in the world (Polunin, 1960, p. 98; Sculthorpe, 1967, p. 366). In western United States it occurs along watercourses, irrigation canals, freshwater springs, and alkaline or even sulphurous seeps.

C. Don MacNeill, J. M. Burns, and J. F. and T. C. Emmel raised *O. yuma* larvae on *P. communis* leaves in the Central Valley of California (Arnaud, 1960; Emmel & Emmel, 1973). J. Scott observed oviposition on leaves at the base of the plant in San Juan Co., Utah. J. F. Emmel and C. Sekerman found ova and larval shelters with leaf edges fastened together to form a tube at Surprise Canyon, Inyo County, California. J. F. Emmel found many last instar larvae in larval shelters at Mesquite Spring, Inyo Co., Calif. *O. yuma* is extraordinarily restricted to *P. communis*; it is almost always found in or within a few meters of stands of *P. communis*. We know of only one record away from *P. communis*, a male from Homewood Canyon, Inyo Co., California, 0.5 mile from *P. communis*.

Habitats with *O. yuma* have only one thing in common: the presence *P. communis*. In the Central Valley of California colonies occur along estuaries, sloughs, and canals. Colonies occur along the Colorado and other rivers in the Great Basin. In desert parts of the Great Basin, colonies are to be found at springs, on alkaline salt-encrusted flats with sufficient subsurface water to support *Phragmites*, and in semi-irrigated streamside marshes. One colony (near Mina, Mineral Co., Nevada) was at a sulfurous spring, and another (Surprise Canyon, Inyo Co., California) was at a seep with *Phragmites* on a hillside. Agricultural activity seems to have increased the habitat for *O. yuma* along the Colorado River drainage in Colorado.

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TABLE 1. Distribution records. Dates are given only for those records not included in Fig. 2.

ARIZONA. *Coconino Co.*: Little Colorado River at Cameron, 4100', K. Roever, and Tilden, 1957; 1 mi. W of Tuba City, 4500', K. Roever; Indian Gardens, Grand Canyon, Tilden, 1957; *Pima Co.*: Tucson, Tilden, 1957 (this record may be dubious, as Mr. Kilian Roever has not found it there).

CALIFORNIA. *Calaveras Co.*: Sand Flats, Tilden, 1957; *Contra Costa Co.*: Antioch, F. H. Chermock, J. Scott, and Tilden, 1957; Bethel Island, J. Scott; Jersey Island, N. La Due; *Inyo Co.*: near Aberdeen, 12 mi. N of Independence, 3840', S. L. Ellis and S. A. Johnson; Antelope Spring, J. S. Buckett; Darwin Falls, J. W. Tilden, L. M. Martin, S. S. Nicolay, R. Holland; Hank Lubkin Ranch, Cartago, C. Henne; Homewood Canyon, Argus Range, 3600–4000', J. F. Emmel & O. Shields; Hunter Canyon, Saline Valley, Los Angeles County Museum; 4 mi. NE of Independence just W Owens River, S. L. Ellis & S. A. Johnson; 2 mi. N Lone Pine, J. S. Buckett; Limekiln Spring, 4000', Surprise Canyon, Panamint Range, J. F. Emmel & O. Shields; Lone Pine Ranger Station road, 5 mi. W Lone Pine, 6500', S. L. Ellis & S. A. Johnson; Mesquite Spring Campground, J. F. Emmel; Olancha, Comstock, 1927; 1 mi. N of Shoshone on Hwy. 127, 1630', J. F. Emmel & O. Shields; Deep Springs, Tilden, 1957; Whitney Portal nr. Lone Pine, S. L. Ellis; Haiwee, Tilden, 1957; Owens Lake, Tilden, 1957; Wyman Creek Canyon, White Mts., 6000', J. F. Emmel & O. Shields; *Mono Co.*: Farrington Camp, Tilden, 1957; Mammoth Camp, Tilden, 1957; *Sacramento Co.*: Bannon Island, F. H. Chermock; South Stone Lake, A. M. Shapiro; Beach Lake, A. M. Shapiro; Jackson Slough Road, Brannan Island, J. Scott; Sherman Island, C. D. Ferris, W. Howe, R. Davis; Twitchel Island, N. La Due; Elkhorn Slough, C. D. Ferris; *San Bernardino Co.*: Topock Marsh, 15 mi. SSE Needles, 500', K. Roever; *San Joaquin Co.*: Bishop Tract, J. Scott; Empire Tract, J. Scott; *Solano Co.*: Suisun Slough, A. M. Shapiro; *Stanislaus Co.*: Modesto, Tilden, 1957.

COLORADO. *Delta Co.*: Austin, 5000', S. L. Ellis; Columbine Ranch Rd., 3 mi. SW Hotchkiss, 5750', S. L. Ellis; Federal Fish Hatchery, SE of Lazear, N. Fk. Gunnison River, 5300', S. L. Ellis; Leroux Creek, #4 Ditch takeout, 5700', S. L. Ellis; *Mesa Co.*: 1 mi. NE jct. I-70 & Hwy. 65, J. Scott; 5 mi. S Debeque, between Debeque & Cameo, Colorado River, J. Scott; Unawep Canyon nr. Gateway, 6300', S. L. Ellis, J. Scott; *Moffat Co.*: Echo Park, Dinosaur National Mon., 5300', J. F. Emmel, O. Shields, S. L. Ellis; *Montrose Co.*: Hwy. 90, 10 road mi. NE Naturita, S. L. Ellis & O. Shields; W. Paradox Creek, nr. Paradox, 5400', S. L. Ellis, S. A. Johnson; *Rio Blanco Co.*: White River, cotypes of *scudderii*.

NEVADA. *Clark Co.*: Cold Creek, Spring Mts., 6200', A. Austin; Corn Creek, J. F. Leser; Corn Creek Station, Desert Big Game Refuge Hdq., 3000', K. Roever, O. Shields, P. Herlan; Moapa, 1600', K. Roever; Logandale, P. Herlan, J. F. Leser; Overton, P. Herlan; Rogers Spring, 8 & 12 mi. S of Overton, P. Herlan; Stewart Springs, ca. 1 mi. W of Overton arm of Lake Mead, P. Herlan; Tule Springs, ca. 10 mi. N of Las Vegas city limits, A. Austin, K. Roever; Whitney Mesa, J. F. Leser; *Elko Co.*: 21 mi. S of Bear Creek Summit (August), P. Herlan; *Esmeralda Co.*: Lida Summit, P. Herlan; *Lander Co.*: Humboldt River NE of Battle Mtn. (August 5), J. Scott; *Lincoln Co.*: 2 mi. N of Caliente, J. F. Emmel & O. Shields; *Mineral Co.*: at the mouth of Cottonwood Canyon, 5.5 mi. SW of Hawthorne, P. Herlan; 4 mi. S of Mina, K. Roever; Whiskey Flats on the Pole Line Rd. 15 mi. S of Hawthorne, P. Herlan; *Nye Co.*: Beatty, J. Scott; 5 mi. N of Beatty, 3500', K. Roever; 5.8 mi. NE of Currant, J. Scott.

UTAH. *Emery Co.*: San Rafael River, jct. I-70, J. Scott; *Garfield Co.*: Calf Creek, 12 mi. S of Boulder, K. Roever; 1 mi. W Henrieville, K. Roever; *Grand Co.*: 12.5 mi. NE jct. Hwy. 128 & Castleton road, Hwy. 128, 3800', S. L. Ellis, O. Shields; *Kane Co.*: N of Glendale, J. F. Emmel & O. Shields; 2 mi. S of Kanab, 4800', K. Roever;

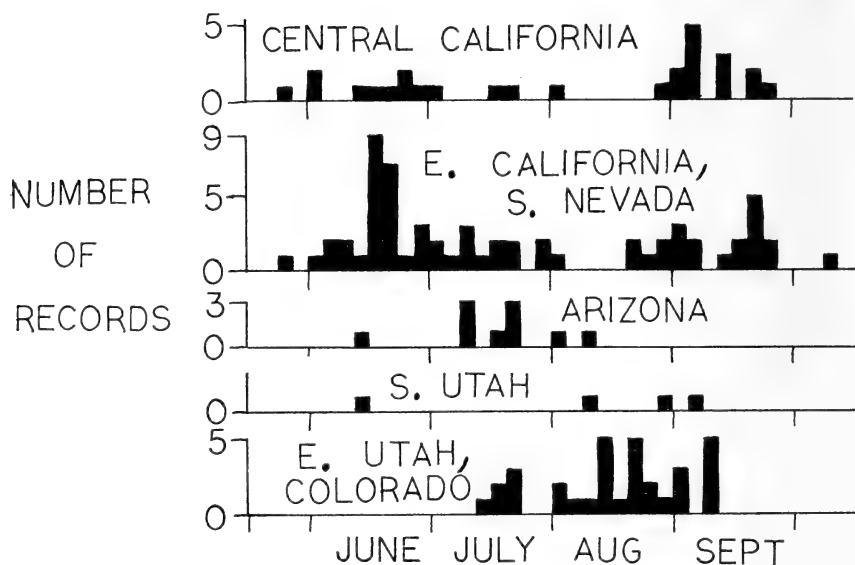


Fig. 2. Histograms of daily collection records (ignoring numbers seen or collected), grouped into four-day intervals, from late May-early October.

localities of *yuma* (Inyo Co., Calif.) and *scudderi* (Rio Blanco Co., Colorado) were treated by Tilden (1961) and Brown (1957).

Colonies usually are very isolated from each other. Like *Speyeria nokomis nokomis* (Edwards), another western United States butterfly found at isolated springs, the current colonies seem to be relicts of a formerly widespread Pleistocene distribution. All of the records we have are within the drainage basin of the Colorado River during the Pleistocene, except the records from the Central Valley of California, where it may have been introduced from the Great Basin during this century. It has only recently been discovered to occur in the Central Valley (Tilden, 1957).

Colonies are often very small; in several cases the area of plants was only about 30×10 m, and at Mesquite Spring, Inyo Co., California, the isolated *Phragmites* patch was only 1×5 m in size. Most of the colonies in the Great Basin are many miles from other *Phragmites* patches. The persistence of these isolated colonies is amazing; it has been thousands of years since wetter Pleistocene conditions may have permitted more extensive populations to exist.

Time of emergence. There are two broods in California and southern Nevada (Fig. 2). In the eastern part of the range there is only one brood

(Fig. 2); in Colorado peak numbers along the Colorado River are several weeks later than at sites farther from the river. Records are too few from southern Utah and Arizona to determine the number of broods. Males slightly precede females in emergence by a few days as in most butterflies.

Behavior. *O. yuma* is a perching species (Scott, 1974), defined as a mate-locating strategy in which males rest at characteristic sites and investigate passing objects in search of females that fly to these sites to mate. *O. yuma* males rest usually on *P. communis* leaves 1–2 m above ground, in a low spot among the *P. communis* or, when the plants grow on a river bank, on leaves or sometimes boulders on the bank side of the plants. Males sometimes patrol among the plants. Males investigate passing objects, usually other males, then usually rest in the vicinity of their previous resting site. Males show perching behavior at all times of day. We found a copulating pair in Moffat Co., Colorado, at 1340 (24-hr. standard time).

Adults have been observed feeding on flowers of yellow *Chrysothamnus nauseosus* (Pursh) Britton, *Grindelia* sp., and *Helianthus* sp., reddish purple *Polygonum pennsylvanicum*, *Cirsium* sp., and *Asclepias* sp., rose-purple *Arctium minus* Schk., and bluish *Aster* sp.

Parasites. A tachinid larval parasite from Contra Costa Co., California was identified as *Spathidexia dunningi* (Coquillett) (Arnaud, 1960).

ACKNOWLEDGMENTS

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BIZARRE CAPTURE OF A BUTTERFLY BY AN AMBUSH BUG

Pyle (1973, J. Lepid. Soc. 27: 305-307) reported the communal feeding of ambush bugs (Hemiptera: Phymatidae: *Phymata* sp.) upon a single adult silver bordered fritillary, *Boloria selene* Denis & Schiffermüller (Nymphalidae). He stated that due to the small size of the ambush bugs relative to the butterfly that the "means of actual capture. . . baffled me." Personal observation of a similar situation has revealed a possible mode of capture.

On 11 November 1968 at the Brackenridge Field Laboratory of the University of Texas at Austin (within Austin), I observed the capture of a dogface butterfly, *Colias (Zerene) cesonia* Stoll (Pieridae), by an ambush bug, *Phymata fasciata* (Gray), on an inflorescence of cowpen daisy, *Verbesina encelioides* Cav. (Gray) (Compositae). *C. cesonia* is common in this area at this season and frequently visits inflorescences of *V. encelioides* for nectar. One particular butterfly was observed to visit several inflorescences in rapid sequence (very little time is spent at a single inflorescence). Upon approaching one inflorescence, the butterfly quickly dipped down to the plant but did not rise immediately to fly to another. Instead, a rapid beating of the wings ensued with the body of the butterfly remaining stationary. Shortly, the butterfly ceased movement but later began beating its wings again.

Investigation of the inflorescence revealed that the butterfly was being held by its proboscis which was caught fast in one of the foretibia of the bug. This impasse (butterfly unable to escape, bug unable to consume a meal) continued for at least fifteen minutes, after which time observations ceased. Possibly the bug could have maneuvered its beak into position to pierce the body of the butterfly. Great strength and elasticity of the proboscis as illustrated by *C. cesonia* would indicate that the proboscis probably would not break (permitting freedom but in a mutilated condition). Body length of the bug was about 10 mm while that of *C. cesonia* averages about 23 mm.

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HYBRIDIZATION OF *CALLOSAMIA* (SATURNIIDAE)

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The genus *Callosamia* Packard contains three closely related species that generally do not hybridize in nature because of effective temporal isolation. These are *C. promethea* (Drury), *C. angulifera* (Walker), and *C. securifera* (Maassen). Although no wild hybrids have been found and I can see only scant evidence of introgression, the species can be easily crossed in captivity. The cross *angulifera* ♂ × *promethea* ♀ has been described and figured by Haskins & Haskins (1958) and Remington (1958), but I find nothing published on other crosses in this genus. Several lepidopterists in the northeastern states of the U.S.A. have made the above cross, and the two following crosses have been reared to adults at least once: *promethea* ♂ × *angulifera* ♀ and *securifera* ♂ × *angulifera* ♀. The rarity of hybrids with *C. securifera* is due to the unavailability of stock of that species.

For three years I have crossed the species of *Callosamia*, with varied success. The purpose of this paper is to describe and figure some of the stages of the hybrids and to discuss techniques that may aid the reader in making crosses with Lepidoptera.

To compare my hybrids described and pictured here with stages of the parent species, the reader is referred to Jones (1909), Packard (1914), Peigler (1976), and the excellent color plates and text in Ferguson (1972). The *C. securifera* larva figured in color by Dominick (1972) shows larger tubercles than almost all those in several broods that I have reared from Florida and South Carolina.

MATERIALS AND METHODS

Because *C. promethea* is rare or absent throughout the South, I obtained cocoons from northern states. Except where noted, all *C. angulifera* stock used was from Clemson, South Carolina and was mostly wild males taken at lights, although some were reared from ova. All *C. securifera* stock was from Berkeley Co., South Carolina, mostly from wild cocoons, although again some were reared from ova.

After adults emerged from cocoons and their wings were dry, they were transferred to a shoebox in the refrigerator. The box contained a wet paper towel to provide humidity. The lower temperature prevented fluttering and prolonged adult life. Females that had mated were kept

in envelopes with wings folded back to minimize wing damage during oviposition.

Adults were hand-paired by a method very different from that described in Collins & Weast (1961). I held moths by the thorax below the wings, but no squeezing of the abdomen was done, as it is not necessary for the female genitalia to protrude. A gentle rubbing together of the posterior ends of the moths usually caused the male to clasp on within a few minutes. Transferring to a foothold was necessary, and if the pair tried to pull apart, I found that blowing strongly on them gave the needed calming effect. Also, it sometimes helped to clip off metathoracic legs of a female that was trying to coax the male to release her.

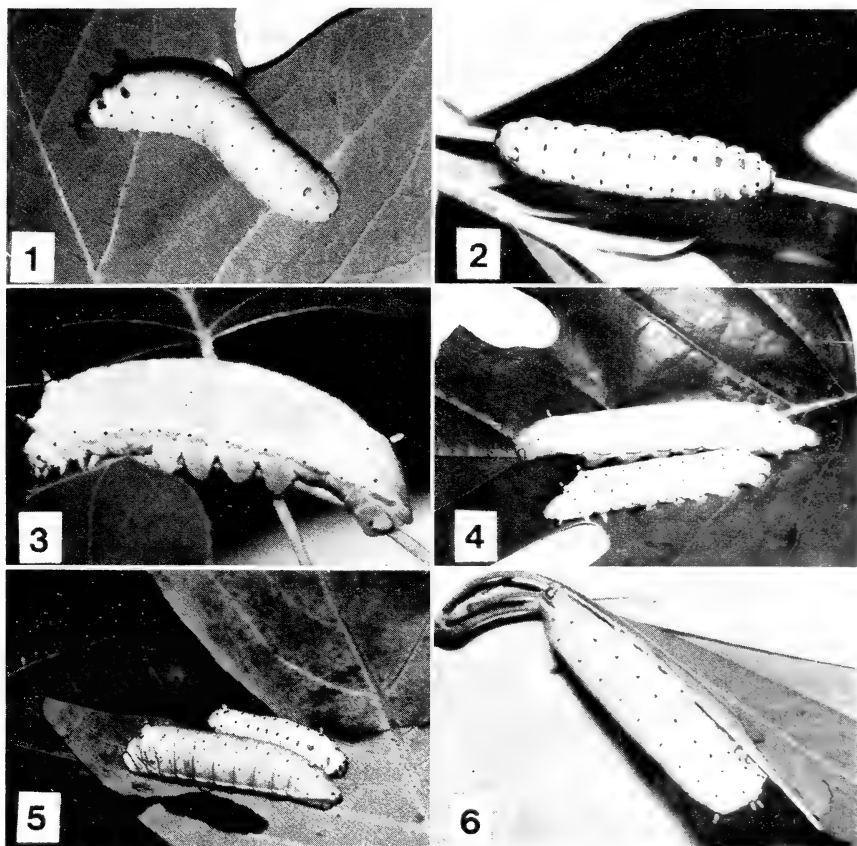
Ova were kept in petri dishes. Upon eclosion, the larvae were put into large cloth bags on limbs of growing foodplants, as ventilation is a must for larvae in this genus. This method of rearing gave larger adults but prevented close observation of the early instars. Therefore, I only describe mature larvae, since the data on early instars are fragmentary.¹ Only in large hybrid broods were any larvae killed for preservation, but those that died of disease or other causes were put into alcohol or the freezer. The late Dr. R. B. Dominick kindly freeze-dried larvae of crosses 2 and 3. All hybrid larvae were reared in Greenville or Clemson, South Carolina on tuliptree (*Liriodendron tulipifera* L.) or sweetbay (*Magnolia virginiana* L.). Cocoons were spun in the bags and, therefore, under natural conditions, although some were spun in folds of the bags rather than on branches among leaves.

DESCRIPTIONS OF HYBRIDS

1. *C. angulifera* ♂ × *promethea* ♀

The ova, supplied by Dale F. Schweitzer, were a mixture from two females reared from cocoons collected on wild black cherry (*Prunus serotina* Ehrh.) in Medford, New Jersey. Both females were induced to emit pheromone after dark by artificial light in Strafford, Pennsylvania and attracted wild *C. angulifera* males; the matings were natural, not hand-paired. The percent hatch was very high. Larvae were reared on tuliptree. A total of 33 cocoons was obtained, which produced 19 males and 14 females. Seven females emerged singly the first spring, but 26 cocoons overwintered again (probably because they were kept in the refrigerator the first winter). The emergence pattern the second spring

¹ My larval descriptions do not involve the various black markings on the head, prolegs, and anal plate because my impression is that they are unreliable because of much variation within the pure species, especially *C. angulifera*.



Figs. 1-6. Larvae of hybrid *Callosamia*. 1, *angulifera* ♂ × *promethea* ♀. 2, *promethea* ♂ × *securifera* ♀. 3, *angulifera* ♂ × *securifera* ♀. 4, *securifera* ♂ × *angulifera* ♀. 5, (*angulifera* ♂ × *securifera* ♀) ♂ × *securifera* ♀. 6, *securifera* ♂ × (*securifera* ♂ × *angulifera* ♀) ♀. (Figs. 1-5 on tuliptree, fig. 6 on sweetbay; all larvae in last instar except smaller one in Fig. 5.)

was spread over 43 days. Excepting two early males, all females emerged singly, then all males emerged singly or in two's.

Larva (Fig. 1): Very uniform in all characters. Red and yellow scoli cylindrical or slightly swollen. Black scoli intermediate in size. Yellow subspiracular abdominal stripe absent.²

Cocoon: All very dark brown, but a few golden before weathering. All but eight with good peduncles.

Male (Fig. 9): Size and outline same as *C. promethea*, yet quite variable. Apex

²This lateral yellow stripe, absent in *C. promethea* and *C. promethea* hybrids, occurs in *C. angulifera*, *C. securifera*, and hybrids between them. A larva hanging head-down on a tuliptree or sweetbay leaf midrib does not seriously disrupt the pattern of the leaf's underside because of this stripe, even if viewed at high angles from either side.

of forewing very pointed and falcate in most specimens. Color intermediate and uniform among individuals, but a few with more golden suffusion beyond postmedian line. Discal spots present but reduced, better developed in forewing. Underside almost exactly like *C. promethea* except for discal marks. A few with sparse scaling on thorax and abdomen.

Male genitalia (Fig. 19): *Callosamia promethea* characters dominant. Costal lobe of valve almost as narrow as in *C. angulifera*, median lobe intermediate, saccular lobe wider than in *C. promethea* but heavily sclerotized and toothed slightly. Posterior opening of anellus V-shaped. In two examples seen, aedeagi identical and intermediate. Cornuti on vesica almost as large as in *C. promethea*.

Female: Color reddish but lighter than *C. promethea* and none orange in color. Highly variable in blackish suffusion in all areas of wings. Discal marks all well developed in all wings of all specimens. Underside with less contrast than *C. promethea*, but marginal lines thicker than in *C. angulifera*. A few with less than normal number of ova.

2. *C. promethea* ♂ × *securifera* ♀

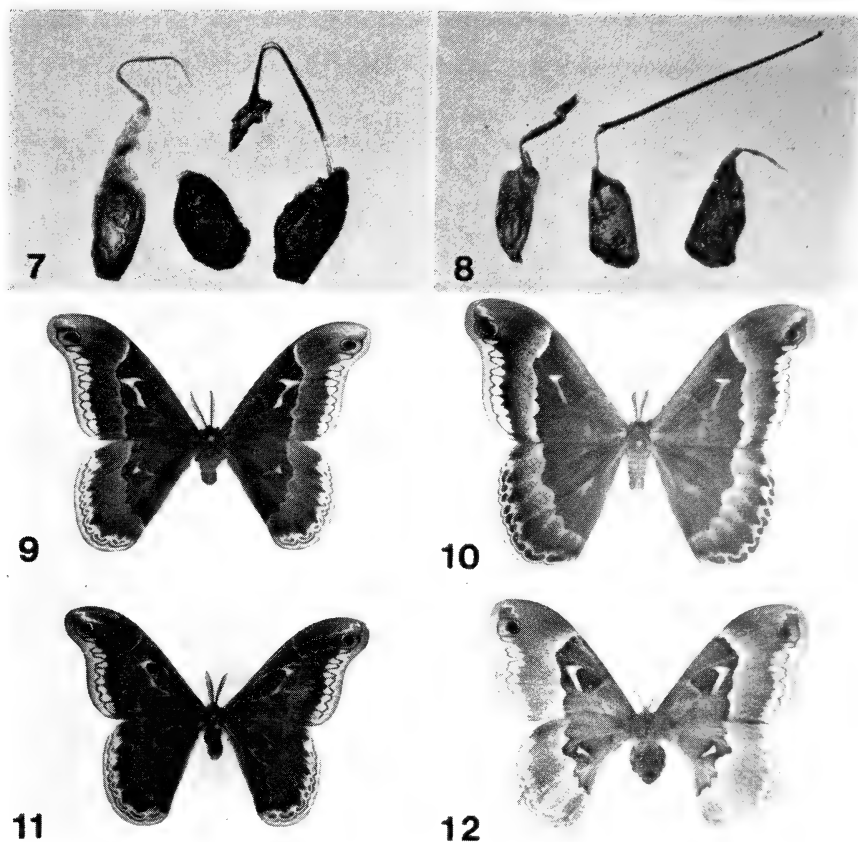
Two broods of this cross were reared. The male used for the first brood was one I reared from Auburn, Pennsylvania. Hatch was 89%. Although newly hatched larvae were offered wild black cherry, they chose tuliptree. Of 55 cocoons obtained, over 40 contained dead larvae that failed to pupate. Only three males were obtained, the other adults being too weak to pull themselves out of cocoons. Emergences were at the end of July.

The following year this cross was made again with a male from Pine Grove, Pennsylvania (reared by Wm. H. Houtz, Jr. on *Lindera benzoin* (L.) Blume). Percent hatch was very high again and about 35 cocoons were obtained; the larvae were reared on tuliptree. Two did not pupate successfully, and I cut open anterior ends of all cocoons to facilitate emergences. In late July and early August, 23 males and eight females emerged in a highly clustered pattern. Many adults had poorly formed wings, some hindwings being scaleless and transparent. Scaling on the body was sparse in all adults of both broods.

A few larvae in the second brood showed a distorted pattern, having segments and scoli out of line. One of these made a cocoon and a male emerged that differed strikingly from the other males by closely resembling pure *C. securifera* with golden suffusion in the postmedian area, larger discal marks, and lighter underside. One cannot ignore the possibility that a genetic correlation existed between the anomalous larva and unique imago.

Females emitted pheromone at "*C. promethea* time" on the first day and during the flight times of both parent species on the second day. A hybrid male in a cage was attracted to, and mated with, a calling sister 3 hr before dark. The ova produced no larvae.

Larva (Fig. 2): Intermediate but homogeneous in appearance. Colored scoli very



Figs. 7-12. Cocoons and adults of hybrid *Callosamia*. 7, *angulifera* ♂ × *securifera* ♀, cocoons. 8, *promethea* ♂ × *securifera* ♀, cocoons. 9, *angulifera* ♂ × *promethea* ♀, male. 10, *securifera* ♂ × (*securifera* ♂ × *angulifera* ♀) ♀, male. 11-12, *promethea* ♂ × *securifera* ♀, male, female.

short and tapered in first brood, cylindrical in other brood. Color bluish as in *C. promethea*; black scoli intermediate. Lateral yellow abdominal stripes lacking.

Cocoon (Fig. 8): Intermediate in size and compactness. Light brown with gray or red cast, never silvery. About 61% had strong peduncles, 25% made weak attachments, and 14% made none.

Male (Fig. 11): Outline like *C. promethea*. Color very dark but not as black as *C. promethea*. Discal marks weakly developed in forewing, usually absent in hindwing. Very minimal golden suffusion in postmedian area. Apices of forewings more pointed than either parent species. Underside intermediate with weak red suffusion past postmedian line.

Male genitalia (Fig. 20): *Callosamia promethea* characters very dominant. Median lobe of valve as large and long as in *C. promethea*, costal lobe intermediate. Anellus opening variable. In one specimen, cornuti on vesica large; in another specimen, cornuti half that size. Aedeagi almost as large as in *C. promethea*.

Female (Fig. 12): Undersized but full of ova. Color dull orange, being between females of parents. Discal marks developed in all wings. Postmedian line less undulating (as in some *C. promethea*) and more proximal than in both parental species. Underside very similar to *C. angulifera*.

Ova: Chorion thin, causing collapse. White color changing to translucent yellow when dry. Size same as *C. promethea*, smaller than *C. securifera*.

3. *C. angulifera* ♂ × *securifera* ♀

About five-sixths of the ova hatched. Most of the brood were reared on tuliptree, but some were reared on sweetbay. The latter grew slower but attained equal proportions as adults. Of 52 cocoons, only a few died. Adults totalled 24 males and 23 females. The emergence pattern ran from 15 July to 25 August with heaviest emergences early in this range. The first 12 to emerge were females, the last ten all males, and between was a mixture. Six cocoons overwintered and adults emerged in early May; five were females.

Larva (Fig. 3): Homogeneous in all aspects. Epidermal color and minute black scoli very close to *C. angulifera*, but colored scoli like *C. securifera*. Lateral stripe prominent.

Cocoon (Fig. 7): Most golden brown, a few dark brown like father species. Intermediate in size but closer to *C. securifera*. About 33% made strong stem attachments, 45% made weak ones, and 22% made no attempt to attach.

Male (Fig. 13): All intermediate but the series quite variable. *Callosamia securifera* characters dominant but larger than in that species. Color dark brown and present, but reduced, discal marks (because they are summer form). Underside of forewing like *C. securifera*; hindwing more intermediate with less contrast than *C. angulifera* but with dark brown median area as in *C. angulifera*. Abdominal terga and anal margin of hindwing maroon as in *C. securifera*.

Male genitalia (Fig. 21): Median lobe of valve short like in *C. angulifera*. Smaller, shorter, more rounded saccular lobe than in reciprocal cross. Anellus opening rounded. Vesica with pair of large cornuti.

Female (Fig. 14): Extremely variable, some assignable to spring form, others summer form, others intermediate. All with traits of both parent species, with *C. angulifera* characters predominating. Color orange with varying degrees of black suffusion. Underside much more like *C. securifera*, but more contrast between median and postmedian areas.

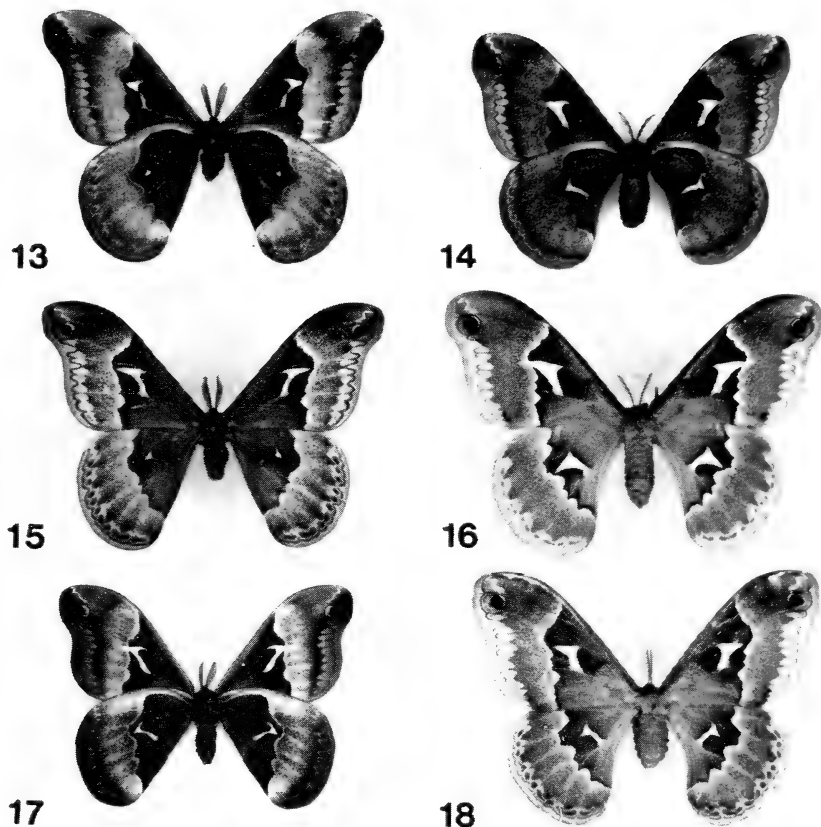
Ova: Size of *C. securifera*, but larger than *C. angulifera*. A few with weak chorion.

4. (*angulifera* ♂ × *securifera* ♀) F₂

A male and female from cross 3 were hand-paired, and six or seven of the 125 ova hatched. Tuliptree was used for food, and two cocoons were obtained that yielded females the following May. One was undersized and weak with thin scaling on the wings; the description below is based on the other specimen.

Larva: Surprisingly like *C. promethea*. Thick red thoracic and yellow scoli cylindrical. Black scoli larger than in most *C. securifera*, approaching *C. promethea*, dorsal ones largest. Abdominal yellow stripes present.

Cocoon: No peduncles. Color of silk and size intermediate.



Figs. 13–18. Adults of hybrid *Callosamia*. 13–14, *angulifera* ♂ × *securifera* ♀, male, female (ventral views). 15–16, *securifera* ♂ × *angulifera* ♀, male, female. 17–18, *angulifera* ♂ × (*angulifera* ♂ × *securifera* ♀) ♀, male (ventral view), female.

Female: One specimen. Would easily pass for pure *C. angulifera* if examined closely dorsally or ventrally. One minor *C. securifera* trait noted—a double distal edge of discal mark on underside of forewing.

Ova: Size like *C. securifera*. Chorion thin, collapsing and color becoming translucent yellow as ova dry, a few remaining white.

5. *C. securifera* ♂ × *angulifera* ♀

Only 21 ova hatched of 128 laid. Larvae were reared on tuliptree, a few being started on sweetbay and transferred to tuliptree in third instar because of higher mortality on sweetbay. Twelve cocoons were obtained and six males and five females emerged in May. One female was observed to emit pheromone during *C. promethea* flight time, ceased

at dark, and resumed for another hour under a 15-watt lamp with reflector.

Larva (Fig. 4): All but one very close to reciprocal cross but colored scoli slightly thinner. Aberrant one (Fig. 4, foreground) very unusual. Color grayer overall. Colored scoli shorter, tapered, and much thicker. Thoracic ones dull brick orange similar to faded ones in freeze-dried specimens. Black scoli large like in *C. promethea*. (Aberrant larva produced female imago closely matching sisters; mother of cross 7).

Cocoon: Of 12 cocoons, half with strong, long peduncle, four with partial, two with none. Color duller gray brown than those of cross 3 and smoother silk. Color and size intermediate, with father species dominant.

Male (Fig. 15): One male (figured) quite unlike brothers, having much golden suffusion. Other males alike, closely resembling males of reciprocal cross, but smaller overall and a bit redder in median area of underside of hindwings. Discal marks not prominent. Abdominal terga and anal margins of hindwings maroon.

Male genitalia: Costal lobe of valve very much like *C. angulifera*, median lobe long, saccular lobe wide. *Callosamia angulifera* traits dominant. Teeth of uncus shorter. Anellus with V-shaped opening. Aedeagus exact length and thickness as in cross 8, but two cornuti much smaller.

Female (Fig. 16): Very close to *C. angulifera* and cross 4. Extremely large discal marks. Underside mostly like *C. angulifera*, but postmedian line much like *C. securifera* (unlike *C. angulifera*). Lateral ornamentation of abdomen more like *C. securifera*. Antennae intermediate. Wing outline rather variable in view of all other similarities.

Ova: Intermediate size. Some with weak chorion, others normal appearing.

6. *C. angulifera* ♂ × (*angulifera* ♂ × *securifera* ♀) ♀

This backcross was done three times using females from cross 3, but fertility of ova and viability of larvae and pupae were low. Hatching ranged from about 10–60%. A total of six cocoons and three adults were obtained; one pair was the spring form and another male a summer form.

Larva: Most intermediate or closer to *C. angulifera*. One with black scoli split into pairs, metathoracic scoli with thick double (disjunct) black base. Black circled area on anal prolegs with black line running through middle.

Cocoon: Dark brown and small like *C. angulifera*, but five of six with silken attachment to branch.

Male (Fig. 17): Spring form (figured) indistinguishable from *C. angulifera*, but size and wing shape more like *C. securifera*. Summer form closely resembling males of crosses 3, 5, and 8. Wing scaling slightly sparser.

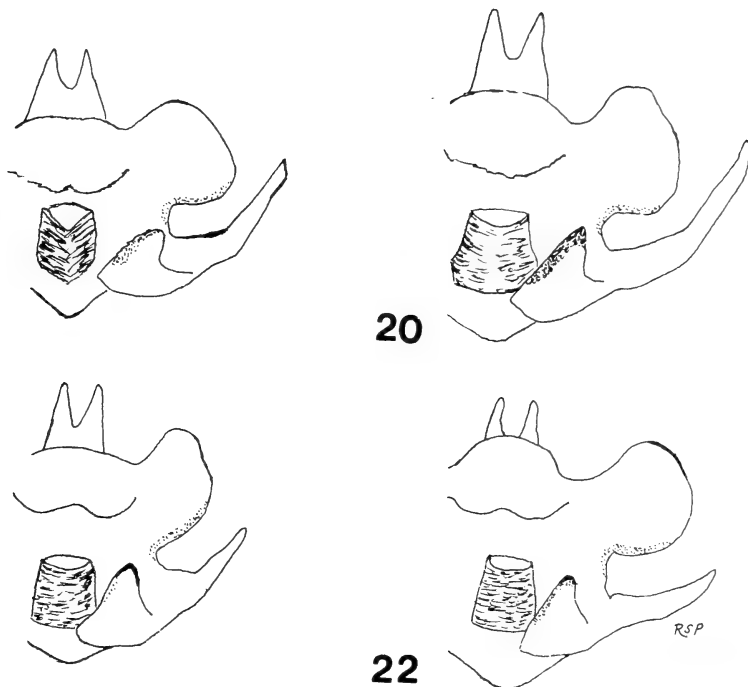
Male genitalia: Like pure *C. angulifera* except for a few minor trends: rounded anellus, slightly longer median lobe of valve, and vesica with larger cornuti. Aedeagus as wide as in *C. securifera*.

Female (Fig. 18): All characters like *C. angulifera* but smaller and browner. Double edge of discal marks on underside barely discernable. Underside areas with much less contrast along post median line than *C. angulifera*.

Ova: Like *C. angulifera*, perhaps a bit larger.

7. *C. securifera* ♂ × (*securifera* ♂ × *angulifera* ♀) ♀

The mother of this hybrid brood was the aberrant larva with larger tubercles mentioned in cross 5. The ova gave 8% hatch, and the larvae



Figs. 19–22. Male genitalia of hybrid *Callosamia*. 19, *angulifera* ♂ × *promethea* ♀. 20, *promethea* ♂ × *securifera* ♀. 21, *angulifera* ♂ × *securifera* ♀. 22, (*securifera* ♂ × *angulifera* ♀) ♂ × (*angulifera* ♂ × *securifera* ♀) ♀.

were reared on sweetbay. Only four cocoons were obtained and one adult.

Larva (Fig. 6): Brood included largest larvae I have ever seen of genus. Black scoli not as large as in mother but larger than in most *C. securifera*. Colored thoracic scoli somewhat light, short, and thick.

Cocoon: A bit smaller and darker than *C. securifera* and peduncle wanting. Very much like *C. securifera* nonetheless.

Male (Fig. 10): Pattern and colors exactly like summer form of *C. securifera*. Hindwings less rounded, more like *C. promethea*. Larger than in *C. securifera*.

Male genitalia: Pure *C. securifera* in all respects. Median lobe of valve slender and longer than costal lobe. Costal lobe squared off. Aedeagus longer than in *C. angulifera*. Two large cornuti on vesica.

$$8. (securifera \delta \times angulifera \text{♀}) \delta \times (angulifera \delta \times securifera \text{♀}) \text{♀}$$

Only eight larvae were obtained from 190 ova laid by one female. Two larvae reached maturity, all others dying in the earliest instars. All were on tuliptree. Two males emerged in mid-July.

Larva: No characters seen to distinguish from pure *C. angulifera*, but possibly less yellowish epidermal color.

Cocoon: No peduncles. Intermediate in color. Almost as large as in *C. securifera*.

Male: Closely resembling males in cross 3 and the summer male of cross 6. Especially red on undersides in postmedian area. Discal marks on forewing average, on hindwing feeble. One male with maroon abdomen.

Male genitalia (Fig. 22): Costal and median lobes of valve more like *C. angulifera*, saccular lobe more like *C. securifera*, less pointed, more rounded. Anellus rounded. Uncus comparatively small. Noticeable bend in aedeagus, which is thicker than in *C. angulifera*. Large cornuti on vesica.

9. *C. (angulifera ♂ × securifera ♀) ♂ × securifera ♀*

Twenty-three of 118 ova hatched, and the larvae were reared on sweetbay until the last two instars, when they were transferred to tulip-tree. All larvae died of a disease except one, which made a cocoon and died at pupation. About a third of the brood was "super-tuberculate" in that there was a dorsal pair of reduced colored tubercles on the first abdominal segment. This peculiar character apparently occurs occasionally in the pure species. It has been reported in X-radiated *C. promethea* stock by Haskins (1934) and is incorrectly given as a constant character of *C. securifera* by Ferguson (1972), although I find only four *C. securifera* larvae of about 30 in the Wedge Plantation Collection show it. That collection also has a few *C. angulifera* larvae (from SE Pennsylvania) with this trait.

Larva (Fig. 5): See discussion above for most unusual characteristic. Black scoli the size of those in *C. securifera* or slightly larger. Scarlet scoli slightly swollen or cylindrical, thicker than in *C. securifera* and *C. angulifera*.

Cocoon: One specimen. Smaller and darker than *C. securifera* but with firm attachment to stem. Silk golden.

10. *C. (securifera ♂ × angulifera ♀) ♂ × [angulifera ♂ × (angulifera ♂ × securifera ♀) ♀] ♀*

I killed the female (Fig. 18) after 72 ova were laid. One egg hatched and the larva was reared to maturity on tuliptree. Unfortunately, it was killed accidentally in the last instar.

Larva: Colored scoli with very thick black bases, especially metathoracic pair. Black scoli size of those in *C. securifera*. Color like *C. angulifera*, and yellow lateral stripe present.

DISCUSSION

One inherent problem in the hybridization project was the large genitalia of *C. promethea* when compared with the other two species. Best results can be obtained with reared *C. promethea* intentionally made undersized by crowding or poor food during larval life. Females of

C. angulifera, *C. securifera*, and their hybrids can be ruptured and killed by mating with a male *C. promethea*. Conversely, it is difficult for *C. angulifera*, *C. securifera*, or hybrid males to clasp onto *C. promethea* females.

A large number of crosses were made that produced no larvae from the ova. In most cases, matings seemed successful, lasting over $\frac{1}{2}$ hr to several hours, and females oviposited freely. These crosses included duplicates and reciprocals of some of the above crosses and seven that involved all three species. An example of the latter is *C. (securifera* ♂ \times *angulifera* ♀) ♂ \times *promethea* ♀, in which the female (from Cedar Rapids, Iowa) laid 157 ova.

If a hybrid that combines all three species is reared, probably one parent will be pure *C. promethea* since all my tests suggest hybrids which involve *C. promethea* are sterile. Ova of crosses between *C. angulifera* and *C. securifera* often give a high percentage of eclosion, and resultant adults of both sexes are partially fertile, as shown by six of my crosses. Hybrid females of the allied genus *Hyalophora* rarely contain ova (Collins & Weast, 1961 and pers. obs.), but all *Callosamia* hybrid females do. Most mortality in hybrid broods occurs in ova and earliest instar larvae.

Some observations were made on certain behavioral traits that are probably polygenic. The attachment of the cocoon (almost always in *C. promethea* and *C. securifera*, rarely in *C. angulifera*) seems to be a dominant trait. Unlike the other two species, females of *C. angulifera* do not oviposit freely. However, all hybrid females that I mated oviposited freely. If the males used in cross 2 came from univoltine populations, it would appear that this trait was not expressed in the offspring. Larvae of *C. promethea* and *C. securifera* regurgitate a green fluid when handled, but I have not observed *C. angulifera* larvae to do so. This trait of *C. angulifera* occurred in hybrid larvae of crosses 3-6 and 8.

Examples of my hybrids can be found in the following private and museum collections: Dale E. Pforr, Canada; Michael M. Collins, California; Dr. Claude Lemaire, France; Wedge Plantation Collection; Los Angeles County Museum of Natural History; United States National Museum. A future paper will describe and figure my hybrids of the cross *C. angulifera* ♂ \times *Samia cynthia* (Drury) ♀.

ACKNOWLEDGMENTS

I am most grateful to Dr. G. R. Carner, insect pathologist at Clemson University, for making all the photographs in this paper. He often took time from his busy schedule to photograph hybrid larvae. Dr. Claude

Lemaire, a saturniid authority and personal friend, very kindly made the genitalic preparations. Dr. T. R. Adkins of Clemson University allowed me to bag tuliptrees in his yard for two summers.

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COCYTIUS DUPONCHEL (SPHINGIDAE): SECOND UNITED STATES CAPTURE

On 30 September 1975 while operating a UV light along Route 29 near Immokalee, Collier Co., Florida, the author took a large male sphingid that under the light appeared to be the resident species, *Cocytius antaeus* (Drury). Upon mounting the specimen, it tentatively was identified as *Cocytius duponchel* (Poey). The specimen was sent to William Sieker of Madison, Wisconsin who confirmed the identification as *C. duponchel*.

This constitutes only the second U.S.A. record for this neotropical species. The other capture of *C. duponchel* within the U.S.A. is from Edwards Co., Texas in May 1902 (Hodges 1971, Moths of North America, Fascicle 21, Sphingoidea, 25). The specimen has been deposited in the Florida State Collection of Arthropods in Gainesville, Florida.

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AGGREGATION BEHAVIOR OF *CHLOSYNE LACINIA*
LARVAE (NYMPHALIDAE)NANCY STAMP¹

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The objective of this study is to describe the larval aggregation behavior of *Chlosyne lacinia crocale* (Edwards) in terms of a daily activity pattern and the relation of larval size to the tendency to aggregate. Although other authors mention these topics, (Edwards, 1893; Bush, 1969; Drummond *et al.*, 1970), they provide little quantitative support for their conclusions.

Chlosyne lacinia crocale ranges from the southwestern United States to Mexico (Emmel & Emmel, 1973). From March–November, adult females deposit multiple broods on leaves of the common sunflower, *Helianthus annuus* L., and related species (Drummond *et al.*, 1970; Neck, 1973; Gorodenski, 1970). There are five instars, each lasting 3–7 days, with an average generation time in the field of 35–40 days (Edwards, 1893; Drummond *et al.*, 1970). Hatching synchronously, the larvae feed gregariously under a silk web on the underside of a leaf through the first instar (Edwards, 1893; Bush, 1969). After a leaf is devoured by a group, individuals move single file to a new leaf using and reinforcing silk thread trails (Bush, 1969). Coinciding with the appearance of distinct larval color patterns, dispersal by single individuals to different leaves and plants occurs in the fourth and fifth instars (Drummond *et al.*, 1970).

METHODS

Larvae were observed on sunflower plants (*Helianthus annuus*) along fence rows in Tempe, Arizona. Observations were made between 0700 and 1800 hours from 10 October–15 November 1975. The mean minimal temperature for this period was 12.1°C, and the mean maximal temperature was 27.7°C. A record was made of the type of plant part used, height on plant of larvae, number of larvae per group, and length of larvae, in mm. Testor's red enamel paint was used to mark the larvae.

To study the tendency to aggregate, 10 portions of sunflower plants were placed in containers with water in the laboratory at 24°C. Each portion had two main stems of about equal diameter, length, and number of healthy leaves, buds, and flowers. On five of these plants, a group of

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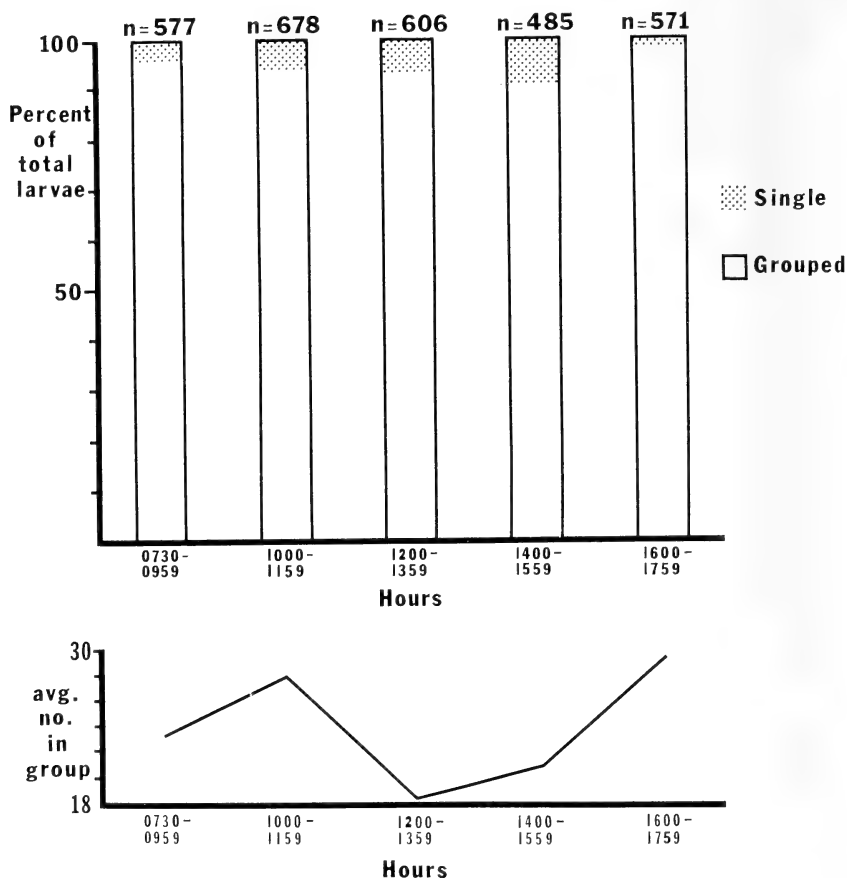


Fig. 1. Daily activity patterns of *Chlosyne lacinia*. Upper—the proportion of solitary and aggregated larvae by 2-hour intervals. Lower—average size of group.

five larvae was placed at the divergence of the two main stems. On each of the other five plants, five larvae were placed singly at diverging stem points. The number of larvae in groups was recorded every half hour for 3.5 hours. This experiment was conducted four times with large larvae (5–10 mm in length).

RESULTS

Small, light-colored larvae (<2 mm in length) usually clustered on the underside of large leaves. Individuals often fed at the same site on a leaf. These groups fed on one large leaf for several days and usually molted before moving to a new leaf.

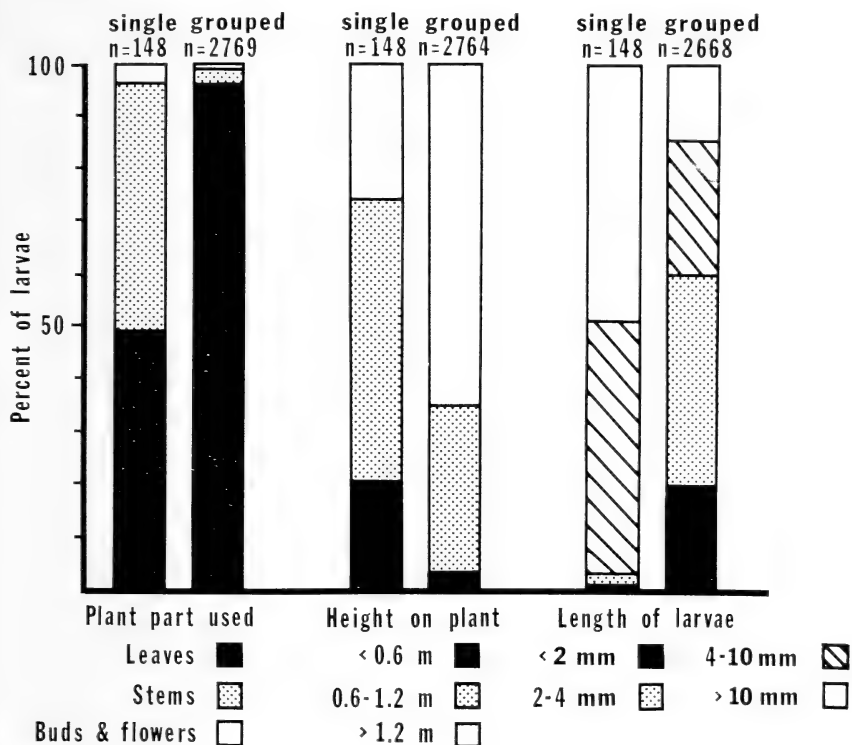


Fig. 2. Comparisons of single larvae and larvae in groups.

Larger, darker larvae (5–10 mm) clustered on one or both sides of a leaf, devoured it in a few hours, and, leaving only the network of the leaf intact and scattered dark fecal pellets, departed for a new leaf.

Tendency to aggregate was dependent on time of day (2×5 contingency table with $\chi^2 = 33.35$ and $p < 0.001$). As a day progressed, the percentage of aggregated larvae decreased to 91.5% and then increased to 98.2% after 1600 hours (Fig. 1). Correspondingly, the average number of larvae per group was lowest after noon and rose sharply by 1600 hours. Throughout the daylight hours, grouped larvae fed exclusively on leaves and spent most of their time on them (Fig. 2). The percentage of aggregated larvae on stems was highest between 1400 and 1559 hours, when larval movement was greatest. Most (97.0%) of the grouped larvae were on leaves higher than 0.6 m from the ground.

Through the day, increasing numbers of single, active larvae were observed, but after 1600 hours, the number of solitary larvae decreased

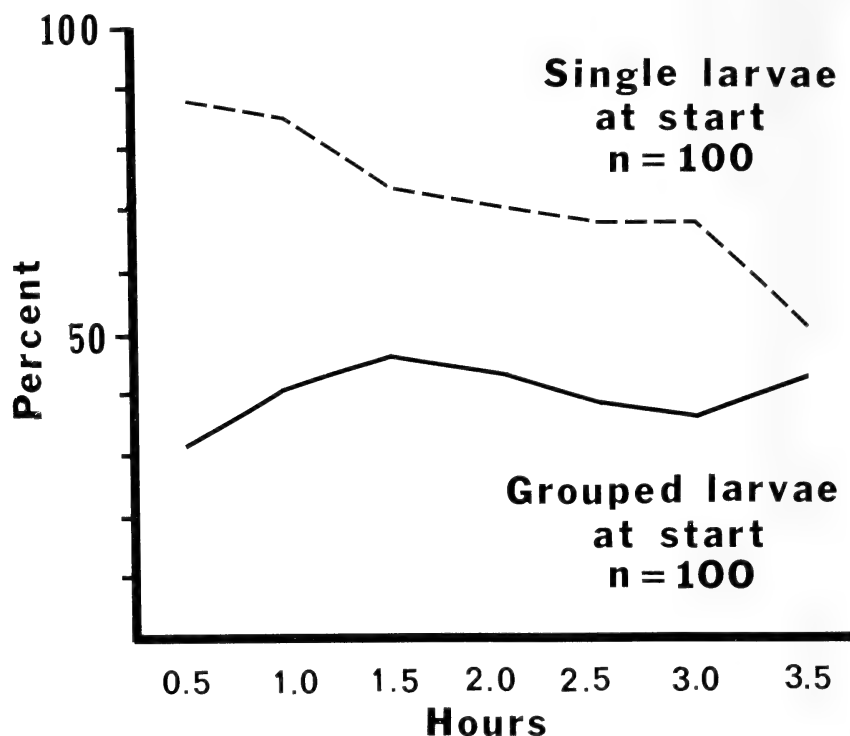


Fig. 3. Testing aggregation tendency. Percent of single larvae are indicated by solid and dashed lines. Larvae placed singly on sunflower stems tend to move until they reach other individuals. Larvae placed in groups tend to remain in groups after some initial scattering. See text for additional explanation.

(Fig. 1). Solitary larvae were encountered more frequently than aggregated larvae on stems, buds, and flowers (Fig. 2). Although the majority of single larvae were found on plant parts higher than 0.6 m from the ground, 26.4% of the solitary larvae were closer to the ground (<0.6 m) as a result of their tendency to wander.

Most (60.0%) of the aggregated caterpillars were <4 mm in length, whereas only 2.0% of the solitary larvae were this small (Fig. 2). Of the single larvae, 50.3% were 4–10 mm and 47.0% were >10 mm.

An experiment was conducted to test whether the larvae tend to aggregate (Fig. 3). The percentage of solitary larvae on plants originally provided with single larvae was compared with the percentage on plants stocked with group larvae. In the first group of plants, percentage of solitary larvae decreased significantly with time (2×7 contingency

table with $\chi^2 = 26.65$ and $p < 0.001$). Percentage of solitary larvae in the second group of plants remained fairly constant (2×7 contingency table with $\chi^2 = 5.55$ and $0.50 > p > 0.20$), with a mean of 41% single larvae.

Several aggregations on sunflower plants were marked to determine whether these groups remained together, but the results were inconclusive. One group of 20 larvae remained together for three days and did not mix with a second group of 67 individuals 0.6 m higher on the plant. However, another marked group of 18 larvae was scattered singly or in pairs over its host plant on the second day. An unmarked group was also scattered, and two pairs of larvae consisted of marked and unmarked individuals.

DISCUSSION

Larvae of *C. lacinia* tend to form groups, with individuals leaving and wandering in the afternoon, then rejoining groups by early evening. The large larvae are more likely to wander and be found as isolated individuals.

What are the advantages associated with the formation of aggregations? Larvae in groups, especially small individuals (<4 mm), exhibited synchrony in feeding, molting, and moving to a new leaf. By moving in a group, individuals may gain an advantage in exploiting the food source. Ghent (1960) found that small larvae of the jack pine sawfly (*Neodiprion pratti banksianae* Roh.) had difficulty boring into pine needles, but once one individual was successful, others could easily join in feeding at that site.

As larvae grow larger, the feeding advantage linked with being in a group decreases. The larger caterpillar can more easily chew into a leaf, and competition for food becomes more intense. Large larvae (5–10 mm) consume leaves at a much faster rate than small caterpillars. Consequently, large larvae move to new feeding sites more often, which requires an increased expenditure of time and energy. If a larva locates a leaf and devours it alone, it will maximize eating time and minimize time and energy expended on movement.

Though probably a function of food competition, dispersal may also reduce disease, parasitism, and predation in the fourth and fifth instars (Drummond *et al.*, 1970). Parasitism is especially high in the third, fourth, and fifth instars, but there is some evidence of differential parasitism among the three larval color morphs (Drummond *et al.*, 1970). Perhaps to avoid pupal parasitism, fifth instars migrate singly to pupation.

Costs and benefits of group membership change radically with age

and size of larvae, which leads to age-linked changes in the tendency to aggregate.

ACKNOWLEDGMENTS

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A MELANIC FORM OF *PHIGALIA STRIGATARIA* (GEOMETRIDAE)

A dark geometrid moth was caught by the author at black light at Lebanon, New Jersey on 5 April 1972. A genitalic slide proved it to be a melanic form of *Phigalia strigataria* Minot. On p. 128 of "A revision of the New World Bistonini," Frederick H. Rindge states that he never saw a melanic specimen of *P. strigataria*. This apparently is the first verified one. I gave the specimen with genitalia slide to the American Museum of Natural History, New York.

Compared with *Phigalia titea* form "deplorans" no difference can be detected. Forewing length of this *strigataria* from apex to base is 16 mm. Small sizes of "deplorans" are also found, but most are larger. Colors of both are the same.

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A REVIEW OF NORTH AMERICAN *RHODOPHAEA*
(PHYCITINAE: PYRALIDAE), WITH DESCRIPTION
OF SIX NEW SPECIES

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As conceived by Heinrich (1956) the Holarctic phycitine genus *Rhodophaea* was represented in North America by two species—*R. caliginella* (Hulst), an oak-feeder, and *R. supposita* (Heinrich), which feeds on Rosaceae. Six species are described here; all feed on members of the family Fagaceae in California or adjoining portions of Arizona and Nevada. Heinrich's *R. supposita*, described from British Columbia, is synonymized with the Palaearctic *R. suavella* (Zincken), and probably represents an introduction by man. The type of genus *Rhodophaea*, *R. advenella* (Zincken), and three other species, (including *R. suavella*), occur in the Palaearctic.

During an ecological study of microlepidoptera feeding on Fagaceae in California (Opler, 1974), six new *Rhodophaea* were reared, and larval shelters probably representing other new species were found.

Forewing color patterns of North American *Rhodophaea* are similar and the identification of any specimen should be based on the examination of dissected genitalia. Variation in color pattern among individuals reared from one host population may approach the variation shown between species. Both male and female genitalia display relatively little variation within reared series, and offer good specific characters.

Members of the genus *Rhodophaea* are extremely similar to those of *Acrobasis* Zeller. Heinrich distinguished *Rhodophaea* chiefly on the shape of the basal antennal segment. Thus, as now conceived, *Rhodophaea* possibly is constituted of several species groups independently derived from *Acrobasis* or its ancestors several times in the Tertiary.

Taxonomic Characters

Forewing color pattern. The scale color markings used are (Figure 1): (1) small elongate patch at base of inner margin, usually dark (*inner basal patch*); (2) basal portion, exclusive of (1), usually pale (*basal area*); (3) post-basal bar extending from costal margin toward inner margin, usually dark contrasting with pale *basal area*, and often edged outwardly with brown, tan or reddish (*basal bar*); (4) a sub-

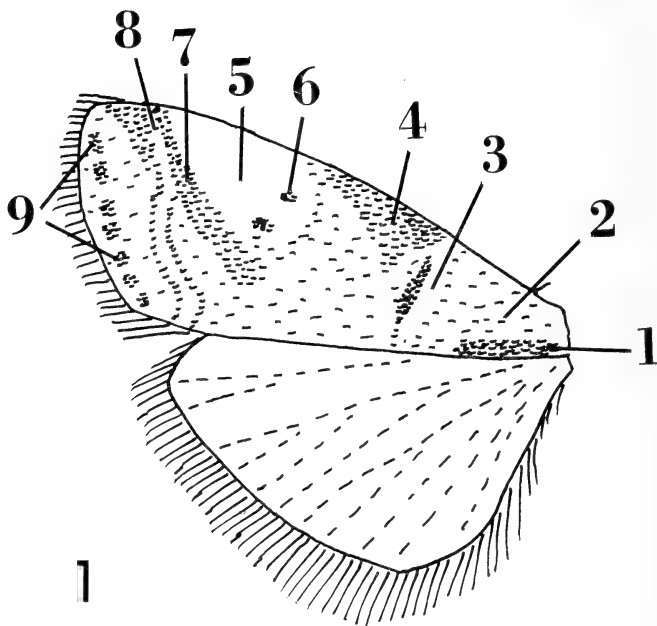
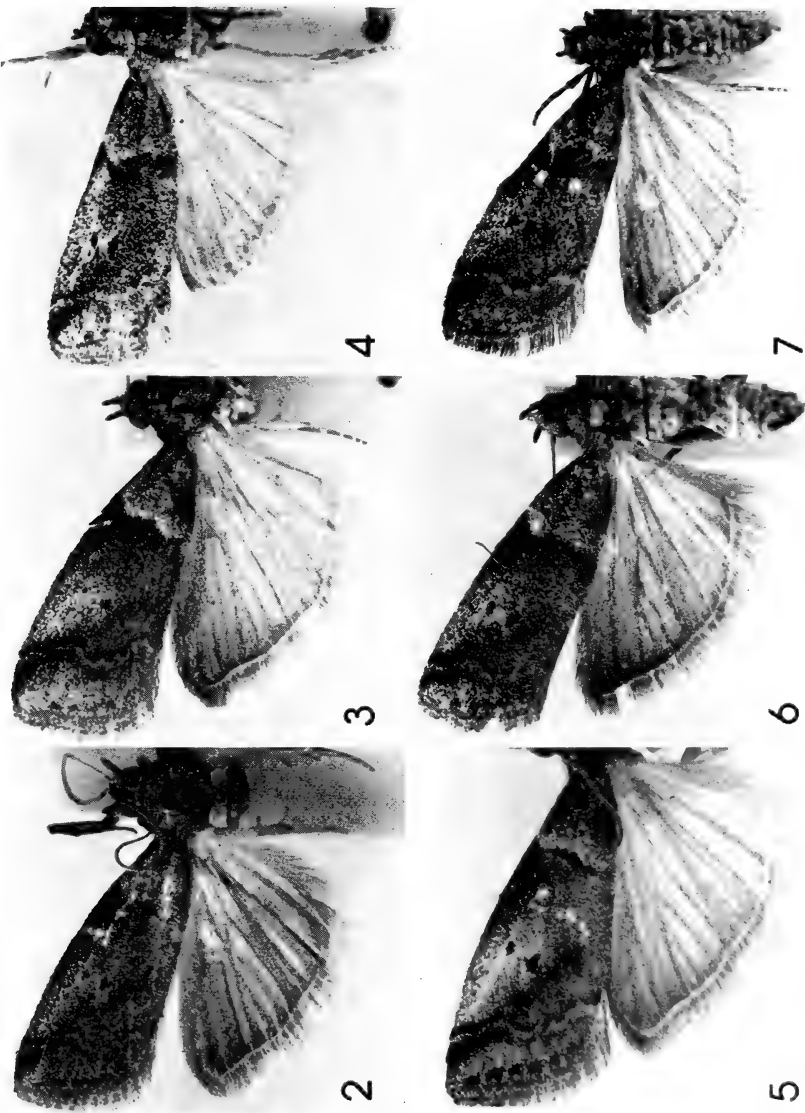


Fig. 1. Diagrammatic illustration of *Rhodophaea* forewing color pattern features employed in descriptions, 1. inner basal patch, 2. basal area, 3. basal bar, 4. s-m patch, 5. p-m patch, 6. spots, 7. band, 8. p-m line, 9. patches.

medial triangular patch of black scales along costal margin, distal to bar (*s-m patch*); (5) postmedial pale area along costal margin (*p-m patch*); (6) two black spots in lower portion of p-m patch (*spots*); (7) a diffuse, diagonal, dark band extending from costal margin inwardly toward, but not reaching, inner margin (*band*); (8) a sinuous pale postmedian line (*p-m line*); (9) and a row of small black elongate patches just inward to outer margin (*marginal patches*).

Genitalia. In male *Rhodophaea* the inner surface of the valva possesses protuberances which are constant in configuration for each species, and are the prime species character used for that sex. In female *Rhodophaea* the number and configuration of the signa bursae are most diagnostic.

Hosts. New World *Rhodophaea* are known to feed on only one or two closely related hosts, e.g., *Rhodophaea caliginella* on *Quercus agrifolia* and *Q. wislizenii*. More than one *Rhodophaea* may be found on the phenotypically and genetically complex *Quercus dumosa-turbinella* populations of mainland California.



Figs. 2-7. Adult *Rhodoplataea*, left fore and hindwings—3×. 2. *R. caliginella*; 3. *R. cruzi*; 4. *R. kofa*, holotype; 5. *R. durata*; 6. *R. futa*; 7. *R. nera*.

Type deposition. Holotypes and allotypes of species described herein are deposited in the California Academy of Science, San Francisco, on indefinite loan from the Essig Museum of Entomology, University of California, Berkeley.

Taxonomic Treatment

Type of the genus: *Phycis advenella* Zincken, 1818.

The type of *Rhodophaea* is quite distinct from known American congeners. The apical process of the gnathos is divided, whereas it is undivided in New World species. The valvae of male *R. advenella* each display one long inwardly directed bar-like projection on their inner face (Figure 16). The corpus bursae of female *R. advenella* lacks pronounced signa, but is covered with minute microspicules (Fig. 20). The ductus bursa is very short when compared to those of New World species. Furthermore, the male of *R. advenella* possesses a mid-ventral hair-tuft on the eighth abdominal segment which is lacking in American *Rhodophaea*.

Rhodophaea caliginella (Hulst)

Fig. 2

Synonymy is given by Heinrich (1956) and Opler (1974). Lectotype designation is given by Opler (1974).

Diagnosis. A large gray moth usually separable from other *Rhodophaea* by the dull black inner basal patch.

Male. Length of forewing 9.5–11 mm (reared). *Inner basal patch* dull black; *basal area* of gray white-tipped scales; *basal bar* a small medial black patch edged outwardly with tan; *s-m patch* a narrow black triangle; *p-m patch* narrow, pale, composed of scales with basal half gray, distal half white; *spots* both distinct, lower the largest; *band* distinct, of black or dark gray white-tipped scales; *p-m line* distinct throughout its length, of dark gray white-tipped scales; *marginal patches* a broken line of five black elongate lines, each composed of shining black narrowly white-tipped scales.

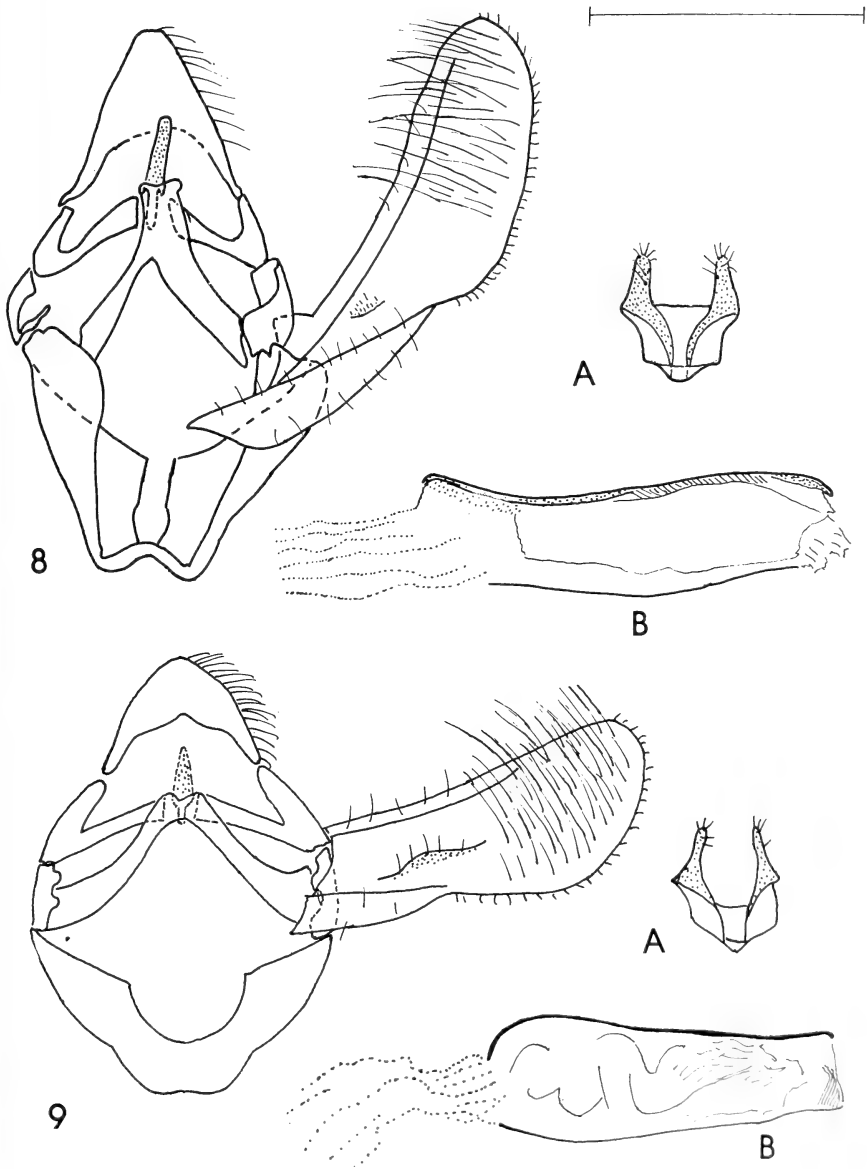
Genitalia. As in Fig. 8, valva with a small indistinct raised area on medial portion of inner face.

Female. Forewing 9–11 mm (reared). As in male except *inner basal patch* not as distinct; *basal bar* with tan scales not as extensive; *spots* upper absent; *band* merging along inner margin with *s-m patch*.

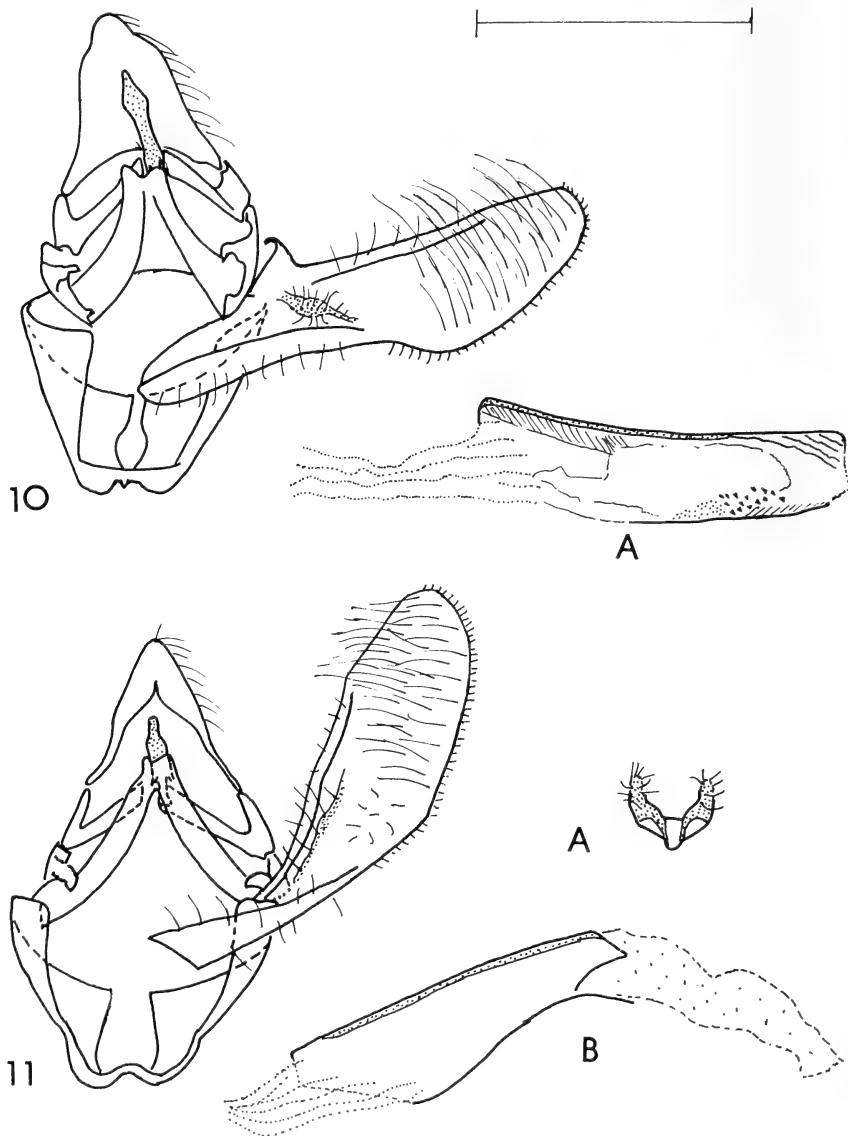
Genitalia. As in Fig. 21, corpus bursa with a small, indented, circular, scobinate patch; distinct signa lacking. Distal two-thirds of corpus bursae with pebbly texture and some minute spine-like projections.

Hosts. *Quercus agrifolia* Nee, *Q. wislizenii* A. DC. and *Q. wislizenii frutescens* Engelm.

Distribution. Known to occur only in California, but is probably also present in Baja California Norte. Distribution is coincident with that of its hosts, from Shasta County south to San Diego County in the coast range, Sierra Nevada foothills (where it is sparsely distributed), the transverse ranges, and the peninsular ranges. The moth is apparently absent from Santa Cruz Island, Santa Barbara County, where suitable hosts occur (Opler, 1970). *Quercus agrifolia* populations on the more remote Santa Rosa Island have not been sampled.



Figs. 8-9. *Rhodophaea*, male genitalia, left valva not shown, aedeagus and juxta removed, A, juxta, B, aedeagus, 8. *R. caliginella*, 9. *R. cruza*. Scale bar = 1 mm.



Figs. 10-11. *Rhodophaea*, male genitalia, left valva not shown, aedeagus and juxta removed, A. juxta, B. aedeagus, 10. *R. kofa*, 11. *R. durata*. Scale bar = 1 mm.

The Arizona specimen referred to this species by Heinrich (1956) may have been mislabelled. The specimen is *R. caliginella*, but neither host of the moth occurs in Arizona, and furthermore, the only documented Arizonan *Rhodophaea* is *R. kofa*, described below from Yuma County's Kofa Mountains, an area remote from the

State's principal oak-dominated habitats. Sampling of most Arizona *Quercus* in 1969 indicated an absence of *Rhodophaea* throughout most of that state.

***Rhodophaea cruzi* Opler, new species**

Fig. 3

Diagnosis. This is the only *Rhodophaea* with a purple-red inner basal patch and purple red scaling distal to the basal bar.

Male. Length of forewing 10–10.5 mm (reared). *Forewing pattern* as for *R. caliginella* male except inner *basal patch* of purplish red scales; *basal bar* a broad purplish red band for posterior two-thirds edged inwardly with a narrow black patch; *s-m patch* dark at costal margin, included scales becoming narrowly white-tipped distally and posteriorly; *p-m patch* with anterior spot absent.

Genitalia. As in Fig. 9, valvae with a low medial linear ridge on inner face extending from near base distally to half distance to tip. Juxta with small lateral projections.

Female. Length of forewing 9.5 (reared). *Maculation* as in male except *s-m patch* and *band* more extensive; both *p-m patch* spots absent; *p-m line* with adjacent reddish scales.

Genitalia. As in Fig. 23. Corpus bursa with single triangular signum composed of pointed projections, and a circular scobinate patch.

Type material. Holotype: male, California, Canada de la Cuesta, Santa Cruz Island, Santa Barbara County, 15 March 1969, reared from *Quercus dumosa*, J. Powell lot 69C40, emerged 30 June 1969, P. Opler prep. 78, P. A. Opler collector. Allotype: female, same data except P. Opler prep. 81. Paratypes: 3 ♂♂, 4 ♀♀ same data except some emerged 29 June and 4 July.

Host. *Quercus dumosa* Nutt.

Distribution. Santa Cruz Island, Santa Barbara County, California.

Discussion. Present evidence indicates this moth is endemic to Santa Cruz Island, yet future study may well alter this assignment. On Santa Catalina Island, Los Angeles County, a single *Rhodophaea* shelter was found on *Quercus dumosa*, so that *R. cruzi* could eventually prove to be endemic to more than one California island. On the mainland, larvae and shelters were found on *Quercus dumosa* throughout much of its range, but only one reared individual exists (a male from Los Angeles County). Color pattern and genitalic features relate this individual to *R. cruzi*, but it differs to such a degree that assignment to that species is unsure.

***Rhodophaea kofi* Opler, new species**

Fig. 4

Diagnosis. The extensiveness of white-tipped scales gives this moth a distinctive "salt and pepper" appearance.

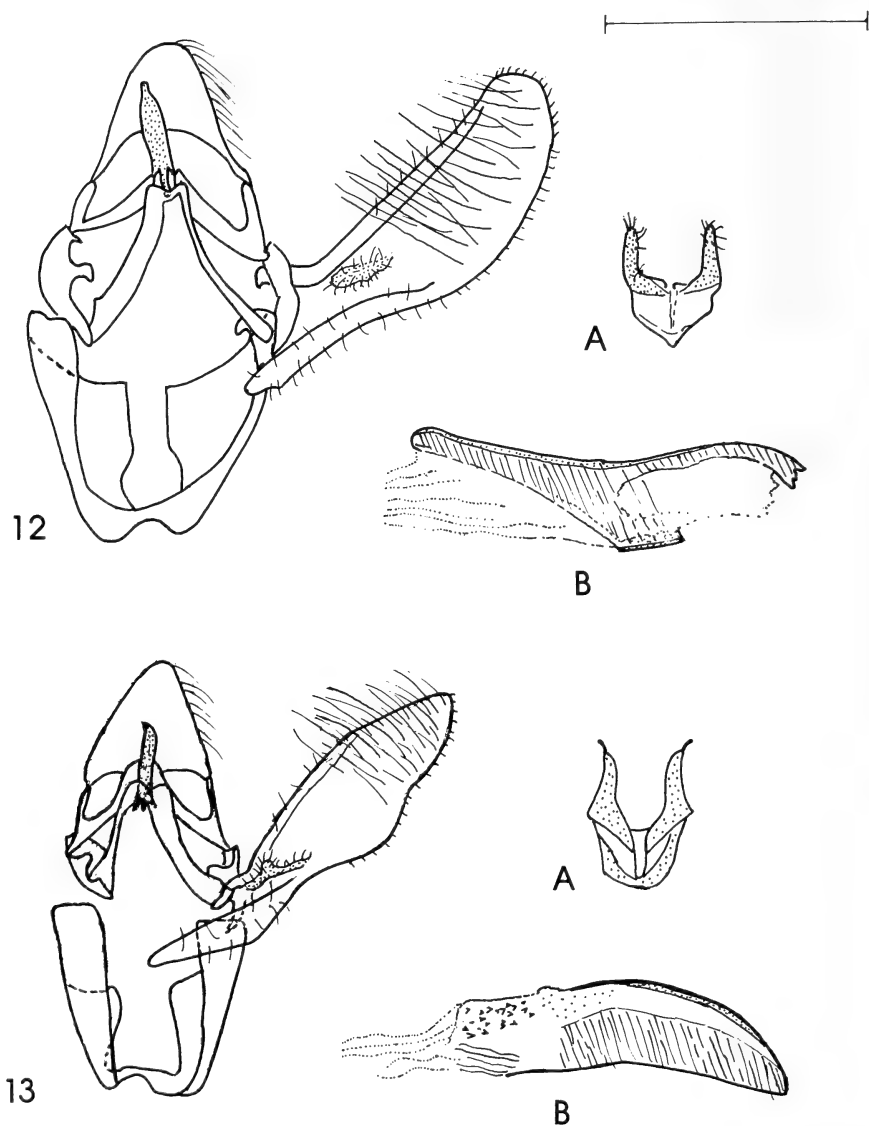
Male. Length of forewing 7–8.5 mm (reared). *Forewing* as for *R. caliginella* male except inner *basal patch* of white-tipped black scales; *basal bar* mostly tan, inwardly edged with narrowly white-tipped black scales; *s-m patch* very restricted in size; *p-m patch* very extensive along costal margin; *spots* both present with narrowly white-tipped black scales; *band* restricted, not extending to inner margin.

Genitalia. As in Fig. 10. Valva with a stout diagonal ridged swelling at base of inner face.

Female. Length of forewing 8.5 mm (reared). *Forewing* as in male except marginal patches extending to costal margin.

Genitalia. As in Fig. 18. Similar to that of *R. cruzi*, corpus bursa with singular triangular signum of pointed projections, and with a circular scobinate patch, denser and more extensive than that of *R. cruzi*.

Type material. Holotype: male, Arizona, Palm Canyon, Kofa Mountains, Yuma



Figs. 12-13. *Rhodophaea*, male genitalia, left valva not shown, aedeagus and juxta removed, A. juxta, B. aedeagus, 12. *R. fria*, 13. *R. neva*. Scale bar = 1 mm.

County, 8 April 1963, reared from *Quercus turbinella* × *ajoensis* hybrid, J. Powell lot 63D11, emerged 12 May 1963, P. Opler prep. 42, C. A. Tauber (Toschi) and J. Powell collectors. Allotype: female, same data except emerged 10 May 1963, P. A. Opler prep. 82. Paratypes: 3 ♂♂, 8 ♀♀ same data except some emerged various dates between 19 April and 31 May 1963.

Host. *Quercus turbinella* \times *ajoensis*.

Distribution. *R. kofa* is known only in the Kofa Mountains, Yuma County, Arizona.

***Rhodophaea durata* Opler, new species**

Fig. 5

Diagnosis. This moth is extremely similar to *R. caliginella* but is separable by the combination of a pale brown or dark gray inner basal patch and the brown scales on the distal portion of the basal bar.

Male. Length of forewing 7.5–9.5 mm (reared). Forewing as for *R. caliginella* male except *inner basal patch* of pale brown scales; *basal bar* of pale brown scales not reaching either costal or inner margins, inwardly edged with narrow black band; *s-m patch* of all black scales, limited in extent; *seven small marginal patches*.

Genitalia. As in Fig. 11. Similar to that of *R. cruzi*. Juxta lacking lateral projections.

Female. Length of forewing 9 mm (reared). Forewing as for male except *inner basal patch* dark gray with a few reddish brown scales intermixed; *basal bar* with reddish brown instead of pale brown scales; *s-m patch* with dark more extensive, merging broadly with *band*; *p-m patch* distinct but reduced in extent.

Type material. Holotype: male, California, Alpine Lake, 1100', Marin County, 25 April 1958, reared from *Quercus durata*, J. Powell lot 58D10, emerged 14 June 1958, P. Opler prep. 75, J. A. Powell collector. Allotype: female, same locality as holotype, 15 April 1972, reared from *Quercus durata*, J. Powell lot 72D10, emerged 27 June 1972, abdomen lost, J. Powell collector. Paratypes: 9 ♂♂, 1 ♀ same locality date, 3 ♂♂ from 1958 collection, 5 ♂♂, 1 ♀ (abdomen lost) from 1972 collection, 1 ♂ 17 April 1970 reared from *Quercus durata*, J. Powell lot 70D48, emerged 3 June 1970, J. A. Powell collector.

Host. *Quercus durata* Jeps.

Distribution. This moth is known only in the slopes of Mt. Tamalpais, Marin County. The range of the moth is presumed to be more extensive, since larval shelters were found on *Q. durata* at Cedar Mountain, Alameda County, and nine miles west of Atascadero, San Luis Obispo County. At other localities where the host was searched no *Rhodophaea* shelters were found, and *R. durata* has an even patchier distribution than its host.

***Rhodophaea fria* Opler, new species**

Fig. 6

Diagnosis. This moth is distinguished by its gray inner basal patch and the fact that the *p-m line* is indistinct near the inner margin.

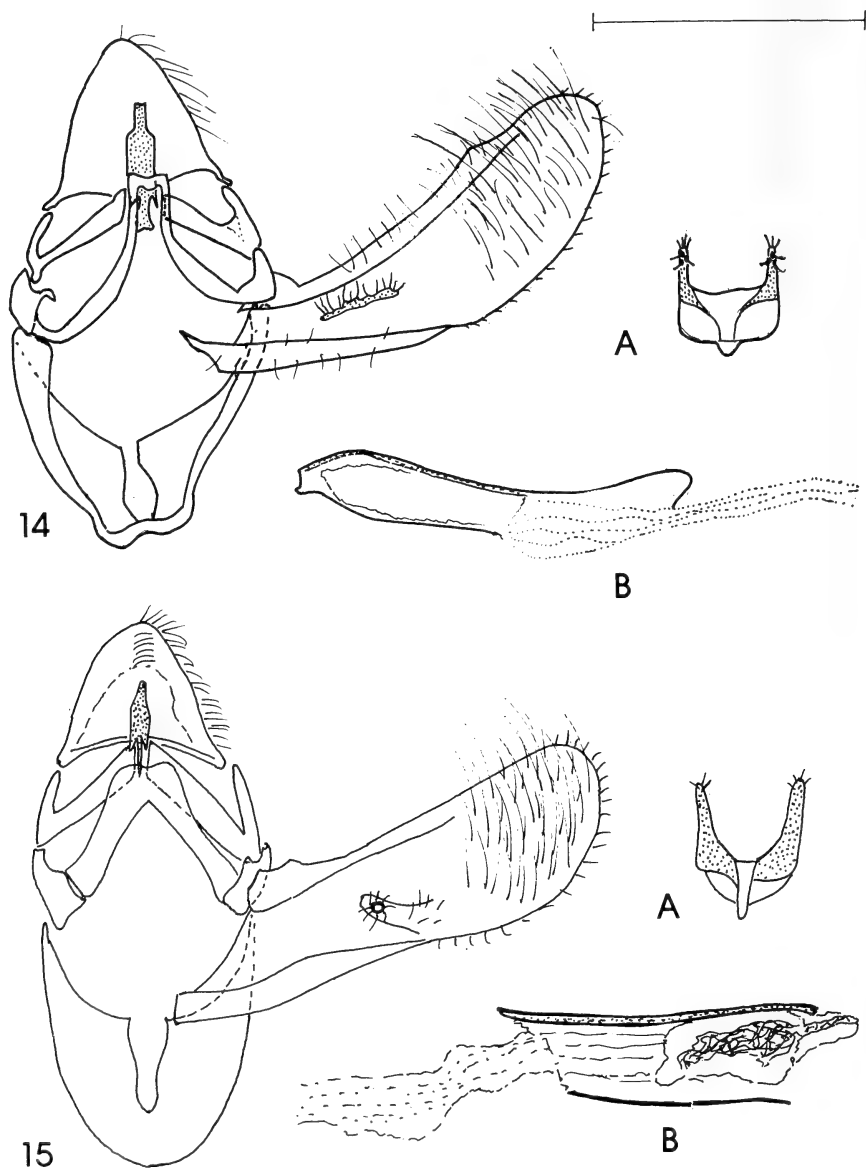
Male. Length of forewing 9.5–10 mm (reared). Forewing as for *R. caliginella* male except *inner basal patch* gray; *basal bar* with outer portion brown; *s-m patch* small, restricted; *band* present, dark on costal margin, paler toward inner margin; *p-m line* indistinct near inner margin, very narrow.

Genitalia. As in Fig. 12. Valva with a bulbous, irregular projection on medial portion of inner face. Juxta with darkened sclerotized areas not extending to base.

Female. Length of forewing 9.5 mm (reared). Forewing as for male except *s-m patch* more extensive.

Genitalia. As in Fig. 17. Corpus bursa with two signa consisting of approximately rectangular patches of pointed projections arranged in rows, and with a small quadrangular patch of scobinations.

Type material. Holotype: male, California, 4 mi. SE Clayton Contra Costa County, 26 May 1968, reared from *Quercus douglasii*, J. Powell lot 68E64, emerged 27 June 1968, P. Opler prep. 35, P. A. Opler collector. Allotype: female, same data except emerged 10 July 1968. Paratypes: 5 ♂♂, 5 ♀♀, same data as holotype, emerged 14 June–5 July 1968; 3 ♀♀, Russelmann Park, Contra Costa County.



Figs. 14-15. *Rhodophaea*, male genitalia, left valva not shown, aedeagus and juxta removed, A. juxta, B. aedeagus, 14. *R. yuba*, 15. *R. suavella*. Scale bar = 1 mm.

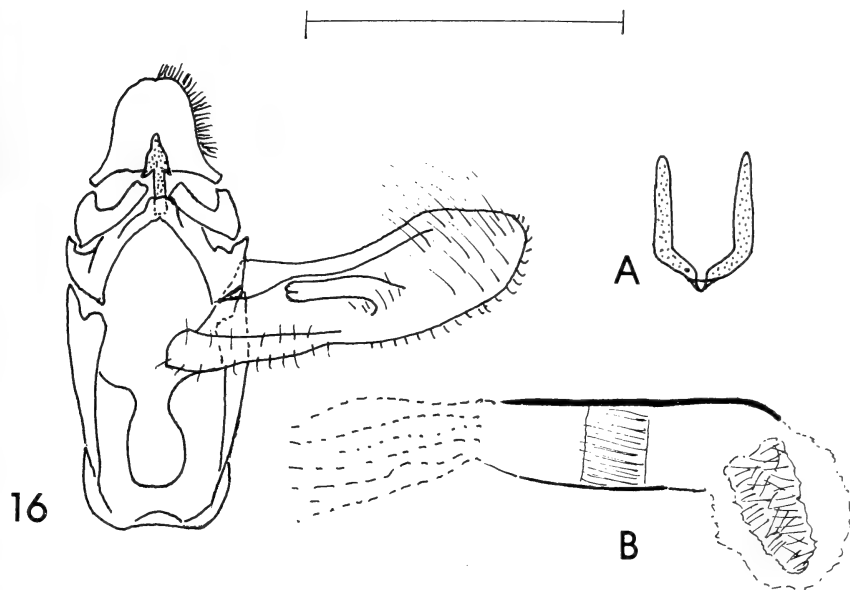


Fig. 16. *Rhodophaea advenella*, male genitalia, left valva removed, A. juxta, B. aedeagus. Scale bar = 1 mm.

California, 11 May 1968, reared from *Quercus douglasii*, J. Powell lot 68E23, emerged 10–14 June 1968; 1 ♂ 8 miles southeast Clayton, Contra Costa County, California, 26 May 1968, reared from *Quercus douglasii*, J. Powell lot 68E53, emerged 27 June 1968, P. A. Opler collector.

Host. *Quercus douglasii* H. T.

Distribution. In addition to adults reared from *Q. douglasii* at localities on the eastern slope of Mt. Diablo, Contra Costa County, shelters were found on this host at Folsom Dam (Sacramento County), 6 mi. SW Mariposa, Mariposa County, and at Keene and 6 mi. S Monolith, both Kern County.

Discussion. This species is the only defined Nearctic *Rhodophaea* which feeds on a deciduous host. The leaves which surround its silken larval shelters are tied to host twigs prior to leaf abscission in fall. The partially grown larvae thus overwinter *in situ* and complete their development on newly produced leaves in the spring.

***Rhodophaea neva* Opler, new species**

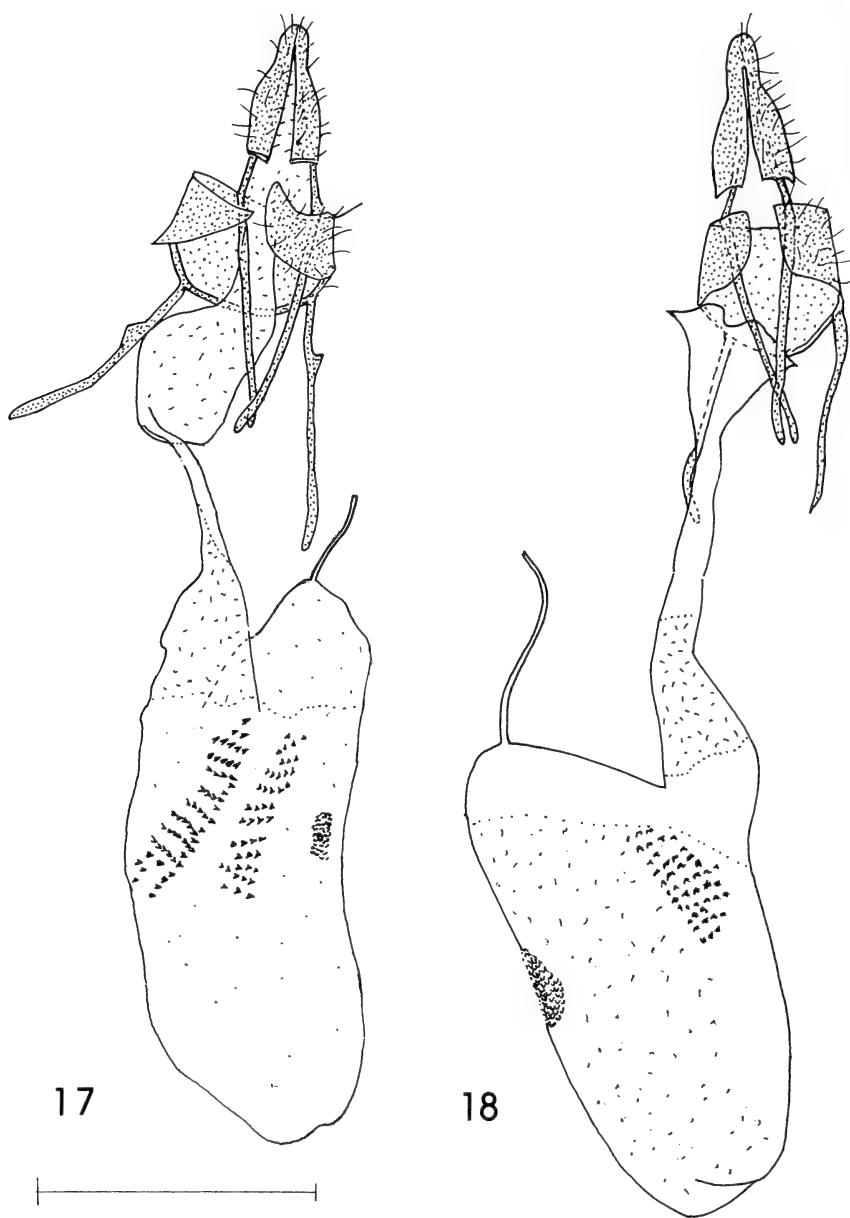
Fig. 7

Diagnosis. This moth is separable by the combination of a dark basal area, broad basal bar, and vague indistinct patches.

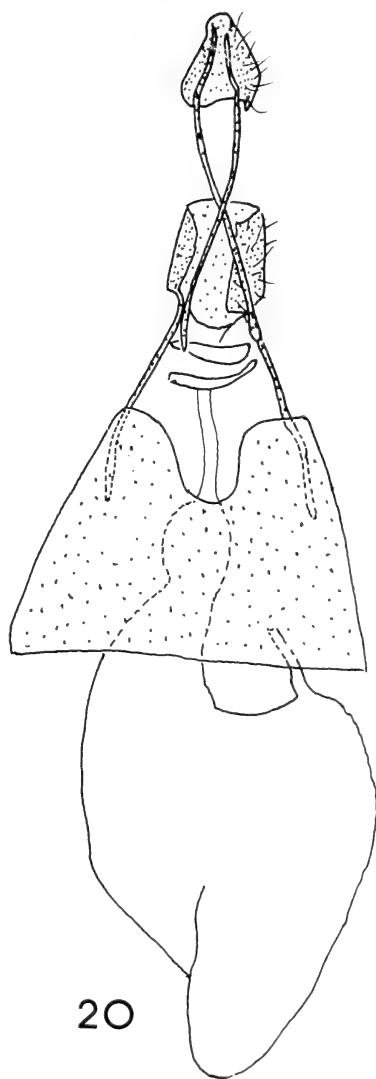
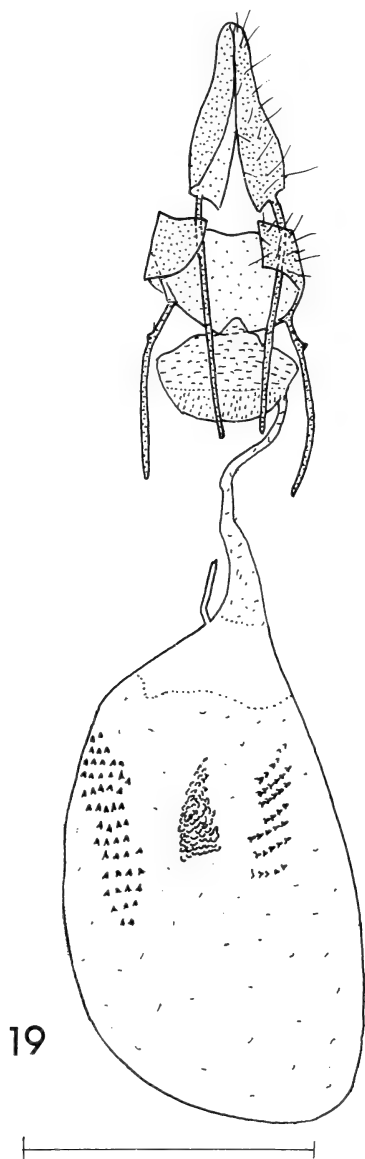
Male. Length of forewing 8.5–9 mm (reared). Forewing scaling of allotype male rubbed presumed to be as in female.

Genitalia. As in Fig. 13. Valva with a ridged projection on basal portion of inner face surmounted by a tubercular process.

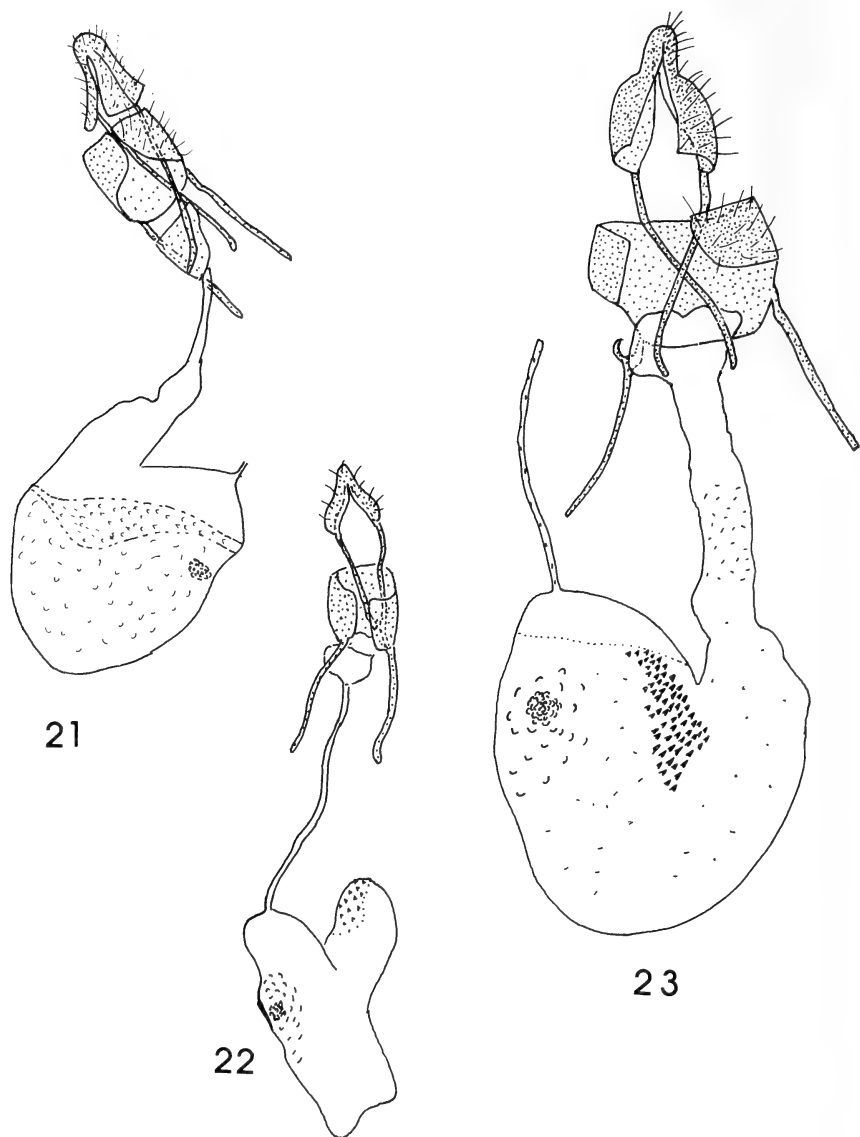
Female. Length of forewing 8.5 mm (reared). Forewing as for *R. caliginella* males except inner basal patch of reddish brown scales; basal area dark, pale only



Figs. 17-18. *Rhodophaea*, female genitalia, 17. *R. fria*, 18. *R. kofa*. Scale bar = 1 mm.



Figs. 19–20. *Rhodophaea*, female genitalia, 19. *R. neva*, 20. *R. advicella*. Scale bar = 1 mm.



Figs. 21-23. *Rhodophaea*, female genitalia, 21. *R. caliginella*, 22. *R. suavella*, 23. *R. cruza*.

adjacent to *basal bar*; *basal bar* broad, of reddish brown scales, inner black portion for posterior $\frac{2}{3}$; *band* especially black at costal margin becoming diffuse inwardly; scattered pale brown scales along inner margin. *Marginal patches* vague, not distinct.

Genitalia. As in Fig. 19. Corpus bursae with two signa similar in configuration to

those of *R. fria*, but with one distinctly larger. The scobinate patch is between the signa, rather than to one side as in *R. fria*, and is triangular in outline.

Type material. Holotype: female, Nevada, summit Kingsbury Grade, Douglas County, 30 June 1968, reared from *Chrysolepis sempervirens*, J. Powell lot 68F108, emerged 9 July 1968, P. A. Opler collector. Allotype: male, same data except 17 May 1969, J. Powell lot 69E88, emerged 29 June 1969. Paratypes: 2 ♀♀, same data as holotype, emerged 6 and 9 July 1968.

Host. *Chrysolepis sempervirens* (Kell.) Hjelm.

Distribution. This moth is known only from the type locality, but it probably occurs at other localities where its host occurs in the Carson Range. No evidence of this species' presence was found at other localities where the host was sampled. Sampling of *Chrysolepis chrysophylla* (Doug. ex. Hook.) Hjelm. failed to disclose evidence of *Rhodophaea*.

Rhodophaea yuba Opler, new species

Diagnosis. This moth has a more uniform pale gray appearance than its congeners, and is further distinguished by its indistinct band and pale gray tan scales on the distal margin of the basal bar.

Male. Length of forewing 10.5 mm (reared). Forewing as for *R. caliginella* male except *inner basal patch* of pale tan scales; *basal bar* indistinct, pale gray tan, narrowly edged inwardly with black; *s-m patch* restricted; *p-m patch* with dull white scales; *band* present but indistinct; *p-m line* distinct but narrow, becoming indistinct toward costal margin; *marginal patches* a distinct narrow broken line, becoming indistinct at inner margin.

Genitalia. As in Fig. 14. Valva with a low irregular ridge-like protuberance on medial portion of inner face. Juxta truncate ventrally.

Type material. Holotype: male, California, Yuba Pass summit, 6708 feet elevation, Sierra County 19 April 1968, reared from *Quercus vaccinifolia*, J. Powell lot 68D152, emerged 10 June 1968, P. A. Opler collector.

Host. *Quercus vaccinifolia* Kell.

Distribution. This moth is known only from the type locality. *R. yuba* may range widely through the range of its host, which was sampled at few localities.

Rhodophaea suavella (Zincken)

Phycis suavella Zincken, 1818.

Myelois suavella: Herrich-Schaffer, 1849.

Eurhodope suavella: Meyrick, 1927.

Rhodophaea suavella: Ragonot, 1893.

Rhodophaea supposita Heinrich, 1956 (New Synonymy).

Diagnosis. This moth is distinguished from other *Rhodophaea* by its dark appearance, absence of an *s-m patch*, and more distal placement of the basal bar which lacks black scaling.

Male. Length of forewing 9–10 mm (reared). Maculation as in *R. caliginella* except *inner basal patch* brown; *basal area* dark, not clearly differentiated; *basal band* positioned more distally on wing, narrow white, not edged inwardly with black; *s-m patch* absent; *p-m patch* strongly reduced; *band* present but indistinct on posterior half of wing.

Genitalia. As in Fig. 15. Valva with long projection on inner face surmounted by a more heavily sclerotized circular setiferous area.

Female. Length of forewing 8.5 mm (reared). Forewing as for male.

Genitalia. As in Fig. 22. Corpus bursa lacking distinct signa, but with an indented scobinate patch on medial portion, and a small area of minute thorn-like projections on proximal portion.

Hosts. Various Rosaceae: *Cotoneaster* (British Columbia), *Crataegus* spp. (England), *Prunus* (France).

Distribution. In North America known only from Vancouver, British Columbia, Canada. In the Palaearctic in southern England, central and southern Europe, as well as the Near East.

Future Taxonomic Work

During the 1967–1970 study of California Oak Microlepidoptera, *Rhodophaea* larvae and shelters were discovered on five hosts from which no reared material is currently available (Opler, 1970). These were *Lithocarpus densiflora*, *Quercus chrysolepis*, *Q. dumii*, *Q. engelmanni* and *Q. garryana*. Moths feeding on *Lithocarpus* can be expected to represent an undescribed species, while at least one and possibly other undescribed species are represented by moths which feed on the other four. The specific identity of *Rhodophaea* associated with *Quercus dumosa* throughout its range must be studied in detail.

ACKNOWLEDGMENTS

J. A. Powell contributed significantly to all phases of this study, and reviewed an early draft of the manuscript. Facilities at the Smithsonian Institution were made available through the kindness of W. D. Duckworth, who made arrangements for the adult photographs. During this study's investigative phase (1967–1970) supporting funds were provided by National Science Foundation grants GB 4014 and GB 6813X (Principal Investigator, J. A. Powell).

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A NEW NORTH AMERICAN SPECIES OF *APAMEA*
FORMERLY CONFUSED WITH *A. VERBASCOIDES*
(GUENÉE) (NOCTUIDAE)

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While "sugaring" for moths in early August 1961, near Lake Kejimikujik, Nova Scotia, in what has since become Kejimikujik National Park, I collected five specimens of a species of *Apamea* Ochsenheimer (formerly *Septis* Hübner) that might have been mistaken for *verbascoides* (Guenée) except that they did not appear entirely normal. Even when sitting on the tree trunks the moths seemed smaller and brighter than *verbascoides*, with the gray and reddish areas of the forewings more prominent and contrasting. The species considered to be the true *verbascoides* is not uncommon in that region and was even collected in the same place on the same field trip. Subsequent investigation revealed that the five unusual specimens represent an undescribed species with distinguishing characters in the genitalia of both sexes. Study of material from other collections disclosed that the new species occurs also in eastern Massachusetts, the vicinity of New York City, and in the pine barrens area of New Jersey. In New Jersey it seems to be much commoner than *verbascoides*.

Although it has thus been apparent for some time that two species are involved, I delayed publishing on this problem because of uncertainty as to the proper application of the one available name, *Xylophasia verbascoides* Guenée (1852: 141), based on specimens collected by Edward Doubleday in the state of New York (probably at Trenton Falls, Oneida Co.). The original description does not give the exact locality or the number or sex of the type specimens; no holotype was specified. Through the kindness of Mr. D. S. Fletcher, I have been able to examine one male and two female specimens in the collection of the British Museum (Natural History) that are believed to be syntypes of *verbascoides*. As expected, these clearly represent the larger, commoner, more widely distributed species. None of the supposed syntypes bears an original type label or any label with the name *verbascoides*, and it may therefore be argued that there is no proof of their authenticity as types. However, there is no doubt that the original description fits this species or its sibling herein described, and Guenée clearly stated the source of the specimens as "Amérique du Nord, Etat de New-York. Coll. Doubleday."

The three examples in question in the British Museum are labelled as Doubleday specimens, and it is reasonable to assume that these are the specimens Guenée described, although we cannot be sure that he saw all of them. Assuming that he did, I hereby designate the male of the syntypic series as the lectotype. It bears the following labels: "699" (on green paper); "Xyloph. Cucullioides Gn."; "U.S. America. Doubleday. 46—110."; "Type" (red-bordered circular label). A lectotype label has been added. Guenée did not describe a *Xylophasia cucullioides*, and the meaning of this label is uncertain. There is no *cucullioides* in *Apamea* or in any closely related genus. However, Guenée made a point of comparing *verbascoides* with species of *Cucullia*, deriving the name itself from that of the European *Cucullia verbasci* (L.), and he may have changed his mind about what to call it; or perhaps he or Doubleday simply made a *lapsus calami* in labelling. Other species that appear most closely related are *Apamea nigrior* (Smith) of the Northeast, which is a much duller brown species, and *A. cuculliformis* (Grote) of western North America, easily distinguished by its larger size, paler coloring, and reduced dark markings on the forewing.

Apamea verbascoides occurs across Canada from Newfoundland to Saskatchewan and in the northern United States from Maine at least to Wisconsin, and southward to Pennsylvania, southern New Jersey, and at higher elevations in the Appalachians to North Carolina. It has one brood which flies from late June to early August. To my knowledge nothing has been reported on the early stages or host plants. The example figured by Holland (1903, pl. 19, fig. 43) is a female of the true *verbascoides*. In the illustrations published by Barnes & McDunnough (1913, pl. 14), figures 1 and 2 are of *verbascoides*, but figure 3 represents the unnamed species, which I describe as follows:

***Apamea inebriata* Ferguson, new species**

Description. Uperside of forewing like that of *A. verbascoides* except for the following differences: areas of brown coloring of a brighter, more red-brown shade, this being especially evident through the middle of the wing longitudinally; costal area with more gray scales; pale zone along inner margin from near base to postmedial line more solidly gray and, especially in fresh females, much more contrasting than in *verbascoides*; basal dash weak or absent and, if present, brown, diffuse, merely a continuation of the deep red-brown shade that runs through middle of wing, not a distinct, tapered, sharp-pointed black streak as in *verbascoides*; small patch of white scales at juncture (or apparent juncture) of M_3 and Cu_1 at outer end of cell, characteristic of *verbascoides*, nearly always absent or much reduced, this point being marked only with a few light yellowish-brown scales or not at all. Although not 100% reliable, this is a very useful character in fresh specimens.

Uperside of hindwing, undersurface, and vestiture of head and body about as in *verbascoides*. No visible differences in antennae, palpi, or other external structures.

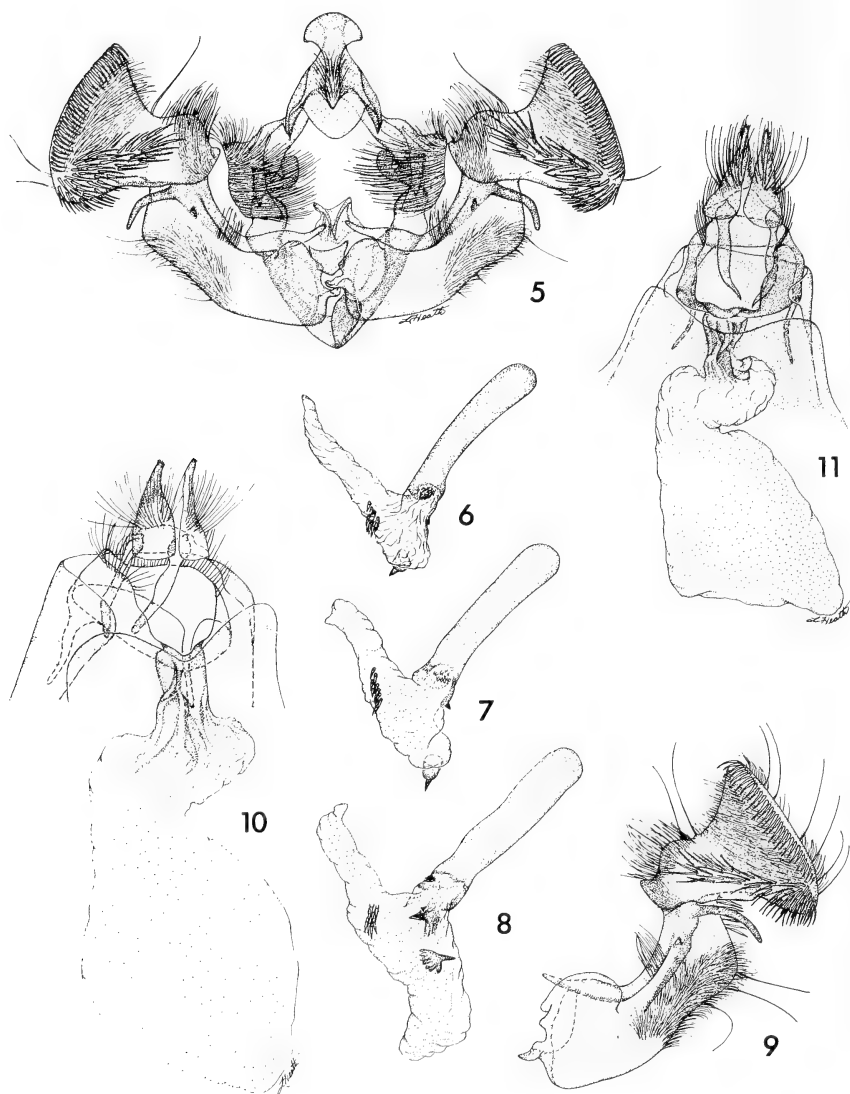
Length of forewing: males, 17–19 mm; females, 15–18 mm; holotype male, 18 mm;



Figs. 1-4. *Apamea* spp. 1, *A. inebriata* ♂, holotype; 2, *A. inebriata* ♀, allotype; 3, *A. verbascoides* ♂, Lake Kejimikujik, Queens Co., Nova Scotia, 8 Aug. 1961; 4, *A. verbascoides* ♀, Halifax watershed area, Halifax Co., Nova Scotia, 28 July 1957. About natural size.

allotype female, 16 mm. Mean wing length: males (of 11), 18.09 mm; females (of 11), 16.95 mm. (For *verbascoides* these measurements are as follows: males, 17.5-20.5 mm; females, 16.5-19.5 mm; lectotype male, 20 mm. Mean wing length: males (of 34), 19.12 mm; females (of 33), 18.27 mm. Although both species are variable, it is thus apparent that the forewing of *inebriata* averages more than one mm shorter than that of *verbascoides*. When series of the two species are compared, the size difference is readily noticeable without measurement.

The most obvious characters in the male genitalia that distinguish this species from *verbascoides* are found in the vesica and in the form of the basocostal lobe of the valve. On the inner face of the valve the basocostal corner takes the form of a large, protuberant, rounded lobe in *verbascoides*, overlying the point of articulation of costa and tegumen; in *inebriata* the lobe is reduced to less than half this size, is somewhat irregular, and does not completely overlie the articulation of costa and tegumen. Also, the lobes are nearly symmetrical in *verbascoides*, more often asymmetrical in *inebriata*, the one on the left valve being shallowly notched, the one on the right valve entire. The sclerotized structures of the aedoeagus and vesica are quite similar in the two species but differently situated, and the vesica itself is differently shaped. The everted vesica consists of two divergent lobes, one being the actual ductus ejaculatorius and the other a blind pouch. The lobe leading to the ductus ejaculatorius bears, dorsally, a cluster of several cornuti similarly situated in the two species. The other lobe bears one large tooth with a broadly expanded base, in *verbascoides* located at about the same relative position as the cluster of small cornuti on the opposite lobe but ventrally; in *inebriata* this large tooth occupies an apical position at the very end of the blind lobe, and the lobe itself is only half as long. There are one or two additional cornuti of intermediate size attached to the wall of the aedoeagus by a straplike connection; in *inebriata* these are smaller, and the straplike connection is only half as long as in *verbascoides*; also, they are located in a left sublateral position instead of being midventral as in *verbascoides*. To the right of this, at the end of the aedoeagus, lies a disk bearing 8 to 20 much smaller cornuti; this is almost exactly ventral in *inebriata* but lies in a right sublateral position in *verbascoides*.



Figs. 5-11. Genitalia of *Apamea* spp. 5, *A. inebriata* ♂, genitalia of holotype, aedeagus omitted; 6, *A. inebriata* ♂, aedeagus of holotype; 7, *A. inebriata* ♂, aedeagus of paratype from Martha's Vineyard, Massachusetts; 8, *A. verbascoides* ♂, aedeagus, West Dover, Halifax Co., Nova Scotia; 9, *A. verbascoides* ♂, right valve of same specimen; 10, *A. verbascoides* ♀, Lake Kejimikujik, Queens Co., Nova Scotia; 11, *A. inebriata* ♀, paratype, Lake Kejimikujik, Nova Scotia.

In the female genitalia the only important difference seems to be in the size of the ductus bursae. This structure is rather rigidly sclerotized, heavily rugose, and finely but densely scobinate in both. In *inebriata*, however, it is shorter and more slender, being no more than two-thirds as thick as that of *verbascoides*.

Types. Holotype: ♂, Lake Kejimikujik, Queens Co., Nova Scotia, August 7, 1961 (at bait), D. C. Ferguson, U.S. National Museum Type No. 74,001 (fig. 1). Allotype: ♀, same data but taken August 6 (fig. 2). Paratypes: 1 ♂, 2 ♀♀, same locality, August 5, 6, 11, 1961, D. C. Ferguson; 1 ♂, Concord, Massachusetts, July 21, 1913, William Reiff; 1 ♂, Martha's Vineyard, Massachusetts, July 29, 1948, F. M. Jones; 1 ♂, "C N.Y./7-8-02," Coll. A. C. Weeks; 1 ♀, "N. York"; 1 ♂, Jerseyville, 3 mi. E of Freehold, New Jersey, July 9, 1961, M. Shulgin; 1 ♀, Freehold, New Jersey, July 17, 1955, M. Shulgin; 8 ♂♂, 3 ♀♀, Lakehurst, New Jersey, June 26–July 27, 1955, J. G. Franclemont; 18 ♂♂, 13 ♀♀, Lakehurst, New Jersey, June 29–30, July 1, 1937, July 1–25, July 4, 1910, July 12, July 17, July 17–30, July 19, July 25, Fred'k. Lemmer; 1 ♀, Lakehurst, New Jersey, July 10, 1928, T. D. Mayfield; 2 ♀♀, Pitman, New Jersey, July 11, 1910; 1 ♀, Elizabeth, New Jersey, "8-6-08"; 1 ♀, Morris Co., New Jersey, May 26, 1937 [wrong date?]; 1 ♀, Jersey City, no date. Holotype and allotype in collection of U.S. National Museum; paratypes in U.S. National Museum, American Museum of Natural History, Peabody Museum of Natural History at Yale University, Franclemont collection at Cornell University, Canadian National Collection, Nova Scotia Museum, and British Museum (Natural History).

Distribution. The localities given for the types represent the entire known distribution, which seems limited to areas near the coast. The type-locality, 30 miles from Annapolis Basin, on the Bay of Fundy, is the farthest inland; the U.S. localities all appear to be less than 20 miles from tidewater.

Early stages. Unknown.

Remarks. The habitat where *inebriata* was collected in Nova Scotia is different from that of the New Jersey pine barrens, being Canadian Zone woodland, although of a rather southern type bordering on Transition Zone. It is characterized by a mixture of second growth white and red pine, red spruce, hemlock, balsam fir, beech, red oak, sugar and red maple, white and yellow birch, aspen, ash, hop hornbeam, and a wide variety of shrubs, mainly those that favor acid soil conditions in that region. The moths were taken along old logging roads on the eastern side of Lake Kejimikujik close to the boundary between Annapolis and Queens counties, and about one-third of a mile north of the Grafton Lake fish hatchery. *Apamea inebriata* is a new addition to the list of northeastern endemics with curiously limited, or disjunct, coastal distributions. I believe that these are relicts of a Pleistocene coastal plain fauna which, in part, survived glaciation on large, emergent island refugia off New England, Nova Scotia, and Newfoundland in a climate tempered by proximity to the Gulf Stream. This was the subject of my paper, *The Grand Banks Refugium*, presented at the 1974 annual meeting of The Lepidopterists' Society.

ACKNOWLEDGMENTS

I am indebted to D. S. Fletcher of the British Museum (Natural History) for the opportunity to see and photograph the types of *verbascoides*, to J. G. Franclemont of Cornell University, F. H. Rindge of the American Museum of Natural History, and J. D. LaFontaine of the Biosystematics Research Institute, Agriculture Canada, for the privilege of examining additional material, and to E. L. Todd of the Systematic Entomology Laboratory for a very helpful review of this paper.

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STAPHYLUS AZTECA, NEW RECORD FOR THE UNITED STATES (HESPERIIDAE)

Staphylus azteca (Scudder, 1872)

Type locality. Tehuantepec, Oaxaca, Mexico.

Distribution. Mexico: Mante, Tamaulipas, June 1967 (H. A. Freeman); Ciudad Valles (Hotel Covadonga), San Luis Potosi, June, July, August 1966-1975 (H. A. Freeman); Tamazunchale, San Luis Potosi, June 1967 (H. A. Freeman); San Blas, Nayarit, September 1966 (W. S. McAlpine); Comala and Colima, Colima, March, April 1967 (Robert Wind); and Catemaco, Veracruz, August 1967 (H. A. Freeman). Guatemala, Salvador, and Costa Rica (various records in the British Museum and American Museum of Natural History, New York).

On 2 June 1940 I collected a female specimen of *Staphylus* at Alpine, Brewster County, Texas, approximately 11 mi. N of town. This specimen was sent to Mr. E. L. Bell at the American Museum of Natural History for determination. In response Mr. Bell wrote that this specimen being a female was not possible to identify as it was not like any they had in the museum and could possibly represent a new species. After searching for males for many years in that general area north of Alpine with no results I finally gave up and left the specimen unidentified in my Texas collection. Recently I re-examined the specimen and compared it with my Mexican *Staphylus* and found it to be *azteca* (Scudder). This represents a new Hesperiidae record for the United States.

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ADDITIONAL MATERIAL OF *SCOPARIA HUACHUCALIS*
MUNROE, WITH DESCRIPTION OF MALE GENITALIA
(PYRALIDAE, SCOPARIINAE)

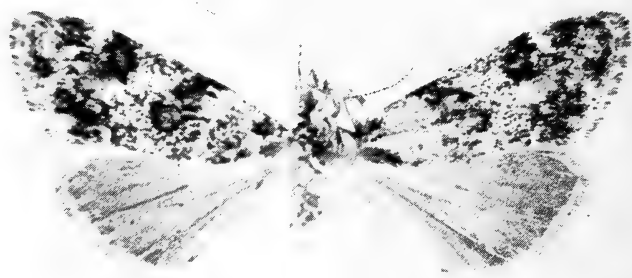
EUGENE MUNROE

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Ottawa, Ontario K1A 0C6

Scoparia huachucalis Munroe was described from a single damaged female in the Los Angeles County Museum. (Munroe, 1972: 46, "1973" [1974]: pl. 2, fig. 42, pl. H, fig. 2). Subsequently, through the kindness of Mr. Julian Donahue, I have been able to examine a short series of better specimens from Madera Canyon, Santa Rita Mountains, Arizona, 6000 ft., 21 May 1940, Lloyd M. Martin. The maculation (Figs. 1, 2) agrees well with that of the holotype, but the reniform spot of the forewing is filled in with light brown and the hind wing is lightly infuscated.

The characters of the male genitalia (Fig. 3a, b) are as follows: Uncus long, narrowly hood-shaped, lightly setose laterally and dorsally. Gnathos narrow, as long as uncus, with short basal section and long, weakly sinuate, slender, strongly sclerotized distal section, finely spinulose dorsally near tip, and with extreme apex decurved and acute. Juxta small, with evenly convex ventral margin, acute lateral angles, and concave dorsolateral margins, converging to the long, acute dorsal extremity. Vinculum with ventral part produced into a short rounded saccus. Valve about three times as long as greatest width, weakly expanded distally, tip symmetrically rounded; costa narrowly inflated; sacculus scarcely inflated, but with distinct free distal spine from ventral margin at about three-fourths from base to tip of valve. Penis curved, about five times as long as wide, with a single short, straight, spinelike cornutus.

The original description of the female genitalia states that the ductus bursae of the female genitalia is slender and membranous. Actually the proximal part of the ductus (Fig. 4a) is weakly sclerotized and tapers for some distance, then there is a short membranous zone leading to a sclerotized and contorted zone, bearing a few spinules; the remainder of the ductus is wider and membranous, leading to the oval to round bursa; the spinules of the latter (Fig. 4b) are arranged in two large patches, facing each other on opposite sides; the spinules of one patch are more widely spaced and larger than those of the other; the large spinules have stellate bases. These features are visible in the preparation



1



2

Fig. 1, 2. *Scoparia huachucalis* Munroe, Madera Canyon specimens. 1, male; 2, female.

of the holotype genitalia and in the figure in *The Moths of America North of Mexico*, but are more obvious in the new preparation.

ACKNOWLEDGMENTS

I thank Mr. Julian Donahue, Los Angeles County Museum of Natural History, for the loan of material as already detailed. Slides of genitalia

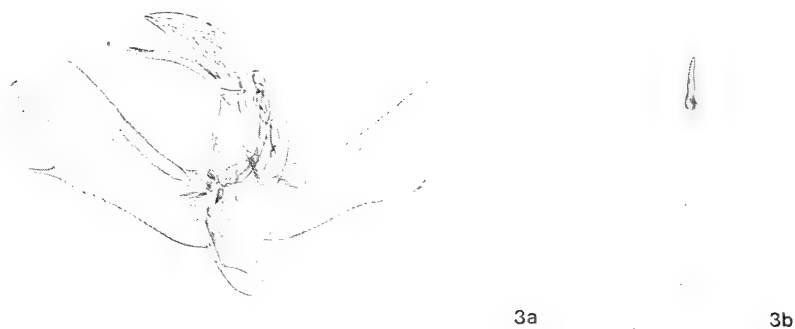


Fig. 3. *Scoparia huachucalis* Munroe, Madera Canyon specimen, male genitalia. a, genitalia with penis removed; b, penis.



Fig. 4. *Scoparia huachucalis* Munroe, Madera Canyon specimen, female genitalia. a, ovipositor, ostium and proximal part of ductus bursae; b, distal part of ductus bursae and bursa.

were made by Mr. Douglas Kritsch, Biosystematics Research Institute. Photographs were made by Mr. Tom Stovell, Graphics Unit, Research Branch, Agriculture Canada, with the assistance of Mr. Kritsch. The plates were mounted by Mr. R. Bennet, Graphics Unit.

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GENERAL NOTES

EFFECTS OF 1933 HURRICANES ON BUTTERFLIES
OF CENTRAL AND SOUTHERN TEXAS

Hurricanes are massive tropical storms that may be accompanied by tremendous winds, precipitation, and/or surge tides. Such storms are normal occurrences in southern Texas, having been observed since the beginning of historical records (Schlesselman, 1945, Trans. Tex. Acad. Sci. 38: 173-182). Two hurricanes struck the Brownsville area in 1933 (5 August and 4 September) causing widespread damage and torrential rains from there southward into Mexico. On 6 July a hurricane struck the Mexican coast approximately equidistant from Tampico, Tamaulipas, and Brownsville. Rainfall from this hurricane in the Brownsville area broke a lengthy drought (July precipitation was 4.50 in. vs the normal of 1.68 in.). Rainfall from November 1932-June 1933 inclusive totaled 8.59 in., compared with a normal rainfall of 13.66 in. for November-June. Precipitation at Brownsville during July-September 1933 was 26.14 in., compared with an average of 9.44 in. (normal annual precipitation is only 26.75 in.). Rainfall in central Texas was unaffected by these hurricanes; San Antonio precipitation during July-September 1933 was 7.94 in. (exactly normal).

Rainfall surges following droughts typically cause large increases in the numbers of many lepidopteran species, some of which subsequently migrate in tremendous numbers. The September storm was very severe, whereas the August storm was relatively minor (names were not applied to tropical storms until 1953). All three storms had profound effects on the biota of southern and central Texas. Three literature reports describe tropical butterfly occurrences that seemingly resulted from these storms, although the observers did not connect their observations with the hurricanes. These three accounts deal with, respectively: 1) initial population movements in direct response to environmental disturbances; 2) establishment, *albeit* temporarily, of a breeding population in the same year as the storms; and 3) apparent overwinter survival and continued reestablishment of a population during the following year.

H. B. Parks (remarks published by Engelhardt, 1934, Bull. Brooklyn Ent. Soc. 29: 16) collected numerous specimens of *Anteos chlorinde nivivera* Fruhstorfer and *Anteos maerula lacordairei* (Boisduval), both Pieridae, at San Antonio, Bexar Co. during the last week of August and first week of September 1933. Parks states, "these huge butterflies were a glorious sight. They arrived in large numbers and stayed with us about a week." San Antonio was apparently the center of the flight, but specimens were also seen or reported at Kerrville, Austin, and San Antonio. Northward movement of these species was apparently in direct response to the August storm. During this same period, and subsequently, he collected the following species: Hesperidae: *Chiomara asychis georgina* (Reakirt); Nymphalidae: *Siprocta steneles biplagiata* (Fruhstorfer) and *Marpesia petreus* (Cramer); Pieridae: *Phocbis philea* (Johanssen); and Heliconiidae: *Heliconius charitonius vasquezae* Comstock & Brown and *Dryas julia moderata* (Stichel). By listing these species, Parks was indicating that these were unusual captures for the San Antonio area. This classification is verified by my observations in the area. The two heliconians are seen in most years in low numbers but normally not until late summer or fall, although early summer occurrence of both species was observed in 1968 (unpub. data). *Siprocta steneles biplagiata* has been observed sporadically in the Austin area.

The second report involves a species that had not previously been seen in Texas or the rest of the United States and probably has not been observed since. A "perfect specimen" of *Dryadula phaetusa* (L.) was collected on 19 December 1933 at Sarita, Kenedy Co. by H. Glazbrook (1934, Ent. News 45: 251-252). *Dryadula phaetusa* apparently was able to disperse northward in late 1933 after the storms and breed at Sarita. Larvae of this species feed on passionflower (Passifloraceae;

Passiflora). *Passiflora foetida* L. var. *gossypiella* (Hamilton) Mast probably occurs in the more mesic wooded habitats of this area. No severe winter weather had been experienced in this area by mid-December 1933. The nearest weather records are for Corpus Christi, Nueces Co. (88 km to the NNE). Ironically, the coldest temperature for late 1933 was 43°F on 19 December. *Dryadula phaetusa* is known from the temperate and tropical regions of southern Mexico but extends up the coasts an unknown distance toward the United States (Hoffman, 1940, An. Inst. Biol. Mex. 11: 639-739).

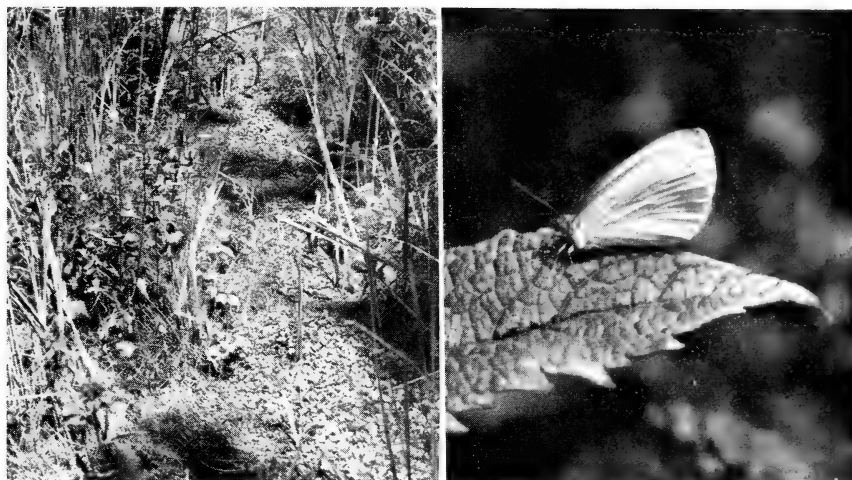
The third report involves the occurrence, which may or may not be associated with these hurricanes, of another tropical butterfly in central Texas. *Anartia jatrophae luteipicta* Fruhstorfer (Nymphalidae) was reported near Sutherland Springs, Wilson Co. in late October 1934 (Parks, 1935, Bull. Brooklyn Ent. Soc. 30: 83). The existence of newly emerged specimens among those collected indicates that a breeding colony had been established. Doubt about the association between the occurrence of this species and these hurricanes results from the observation of this butterfly west of San Antonio on 9 November 1931 by A. J. Boyles. However, Parks (op. cit.) states that "a very careful search has been made [since 1931] without success [until 1934]." Therefore, occurrence of *A. j. luteipicta* in central Texas is believed to be the result of a colony established in late 1933 (or early 1934) after northward dispersal associated with the hurricanes of August and September 1933. Normally, *A. j. luteipicta* would not be expected to survive the winter cold of central Texas. However, the winter of 1933-1934 was exceptionally warm; the coldest temperature recorded at San Antonio (45 km NWW of Sutherland Springs) was 29°F. A population was probably established in late 1933 with successful overwintering and survival until the following winter. Survival through the 1934-1935 winter is unlikely (low temperature 18°F). Survival between the 1931 sighting and the putative 1933 establishment is unlikely since colder weather occurred in both 1931-1932 (low temperature 24°F on 13 March) and 1932-1933 (low temperature 12°F).

In September 1967, Hurricane Beulah, after striking land at the mouth of the Rio Grande River near Brownsville, Cameron Co., Texas, brought extremely heavy rains to southern Texas. As a result of this storm, a fairly large number of lepidoptera species previously unknown in Texas (and the United States) have been reported in southern Texas (Doyle, 1970, J. Lepid. Soc. 24: 212; Heitzman, 1970, Mid-Cont. Lepid. Ser. 12: 10-11; Heitzman & Heitzman, 1972, J. Res. Lepid. 10: 284-286; Kendall, 1970, J. Lepid. Soc. 24: 59-61, 266; Kendall, 1972, *Ibid.* 26: 49-56). At least some of these species have established permanent populations in this area (see later collections reported by Tilden, 1974, J. Lepid. Soc. 28: 22-25).

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COLONY OF *PIERIS NAPI OLERACEA* (PIERIDAE) IN INDIANA

According to Blatchley (1891, Ann. Rep. Indiana State Geol. 17: 365-408), *Pieris napi oleracea*—*aestiva* Harris was collected by Mr. A. B. Ulrey in Kosciusko Co., Indiana in the summer of 1890. When collecting extensively in Kosciusko Co. and other northeastern counties in the mid-1930's and from 1964-1970, I failed to locate *P. napi*. On 12 July 1971, John Campbell, a high school student in my collecting party, collected one in the Pigeon River State Fish and Game Area, Mongo, LaGrange Co., Indiana. My identification of this specimen as *Pieris napi oleracea* Harris was confirmed by Mr. Harry K. Clench of the Carnegie Museum. John and I returned to Mongo on 24 August 1971 and collected 23 more specimens. Since that time *P. n. oleracea* has been found annually in the Mongo tamarack bog, the largest bog of its type in Indiana and only 7 miles from the Michigan border.



Figs. 1-2. 1, left, habitat showing *Barbarea* sp., one of favorite larval foodplants of *Pieris napi oleracea*, Pigeon River State Fish and Game Area, Mongo, Indiana; 2, right, close up of *P. n. oleracea*, second summer brood (photographs by David Eiler).

Recently this species has suffered a great restriction in habitat, partly because of competition with *Pieris rapae* and partly because of habitat destruction by man. In the north central and eastern states *P. napi* is found only in the Transition and Canadian zones, not extending south of the Catskill Mountains in New York (Klots, 1951, A field guide to the butterflies, Houghton Mifflin, Boston, 349 p.). Old records are unreliable since *P. napi* was often confused with *Pieris virginienensis*, a single brooded species of more southern (Transition Zone) distribution. *Pieris rapae*, a species accidentally introduced from Europe into Quebec about 1860, has spread rapidly throughout most of North America (Howe, 1975, The butterflies of North America, Doubleday & Co., Inc., 633 p.). *Pieris rapae* continues to invade *P. napi* territory. *Pieris n. oleracea* formerly occurred in northern Illinois, but it is now apparently extinct in the state (Irwin & Downey, 1973, Illinois Nat. Hist. Survey, Biological Notes 81: 1-60). Thus, additional notes and records of this species in Indiana should be of interest to entomologists.

Not only is *P. napi* geographically variable, but the generations of *P. n. oleracea* vary from one brood to another. On 19 May 1975 I collected the spring form in the Mongo tamarack bog. It had the veins prominently marked. On 1 July 1975 I collected 18 of the summer form (second brood) and observed dozens more flying in the bog. Members of this large colony flew up and down the bog, concentrating on a very limited patch of water cress (*Barbarea*) (Cruciferae) that nearly choked the narrow stream (Fig. 1). Jewelweed (*Impatiens*), shrubby cinquefoil (*Dasiphora fruticosa*), the beautiful but dangerous poison sumac (*Rhus vernix*), narrow-leaved and broad-leaved cattail (*Typha*), and other plants were growing in this area among the scattered tamarack trees (*Larix laricina*). *Euphydryas phaeton* was flying nearby, not far away from its larval foodplant, turtlehead (*Chelone glabra*). Most of the July *P. n. oleracea* were plain white, except for the blackish basal dustings and traces of black on the apical border; a few had washes of yellow on the underside of the hind wing. A specimen collected on 20 August 1974 had a faint dark spot in cell M_3 of the front wing, a rare variety. In a letter to me, Mr. Clench describes the spring

brood as having sharp, almost black, thin lines on the veins of the hind wing underside, whereas the summer brood has no black striping on the veins (Fig. 2). In both broods the underside ground color on the hind wing and apex of the front wing is yellowish. Of the 18 collected on 1 July 1975 only three were females. The females are more seclusive and thus better protected for reproduction. Occasionally a few *P. n. oleracea* left the bog, flying into an adjoining open field. A few *P. rapae* likewise flew into the bog, mingling with *P. n. oleracea*.

I found two separate colonies of *P. n. oleracea* in the bog, one at the eastern end of the Pigeon River camp grounds and the other at the western end. The two colonies were about one quarter of a mile apart. Collecting in the bog can be somewhat dangerous, not only because of the ever-present poison sumac, but because of the sponge-like soil, which makes the collector feel as if he were walking on a spring coil mattress. When I occasionally lost my footing, I simply fell forward and the vegetation easily supported my weight. Suprisingly, by 10 July 1975, I found only three *P. n. oleracea* in the bog, but by 31 July their numbers had greatly increased. Again I collected 18 and saw dozens more. The highlight of the day came when I found a pair *in copula*. It was 1235 EST and the temperature was 90°F. The pair was settled low in the grass and did not fly, even when I placed the net over them. When I touched the male through the net, it lifted the female upward. In the *Pieridae* I have found that only the males are the flight partners. After making these observations, as a conservation measure, I released the mating pair, which remained *in copula*.

On 18 August 1975, Dr. David L. Eiler and I collected in the two colonies at Mongo. I netted 25 *P. n. oleracea* but released six of them. Dr. Eiler caught seven, the first he had ever seen in their natural habitat. Dozens more were seen flying and feeding in the bog, and a few in the open field. In the bog itself, the *P. n. oleracea* far outnumbered the *P. rapae*.

These data show that there were at least two broods of *P. n. oleracea* in the Mongo bog in 1975 and that the species seems to be well established in LaGrange Co., Indiana.

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AN ECOLOGICAL NOTE ON *POLITES SABULETI SABULETI* AT THE NORTHERN LIMIT OF ITS RANGE (HESPERIIDAE)¹

The Sabuleti Skipper, *Polites sabuleti sabuleti* (Boisduval), is reported here for the first time as occurring in southern Canada, at Penticton in the Province of British Columbia. This locality represents the most northerly distribution of this skipper, the known geographic range of which extends from Washington State to Baja California, the Great Basin east to Colorado, and through western Arizona south into Mexico (MacNeill 1975, Family HesperIIDae, p. 423-578 in Howe, ed., The butterflies of North America, Doubleday & Co., Inc., New York). Its presence as an abundant and apparently established species at Penticton was discovered only recently. Previous faunal studies in southwestern Canada have omitted any mention of this skipper (Gregory 1975, Checklist of the butterflies and skippers of Canada, Lyman Ent. Mus. & Res. Lab. Mem. 3, 44 p.). Its range, therefore, seems to have been extended into southern British Columbia at some time during the quite recent past.

Field observations indicate that this skipper is bivoltine at Penticton. The flight period of the adults extends from late May to early July and occurs again during

¹ This paper was presented at the joint meeting of the Washington State Entomological Society and the Oregon Entomological Society in Pullman, Washington on 25 September 1976.

the latter part of August and early September. The bivoltine condition prevails in Washington State as well (MacNeill, *op. cit.*).

At Penticton, the observed nectar sources visited by adults of this skipper comprise two groups of plants in particular; namely, phlox and knapweed. During the flight period of the first generation, the major nectar source is *Phlox longifolia* Nutt. This plant possesses pink or lavender-coloured blossoms from May into June, and it is found abundantly as far north in the dry interior as Peachland (Lyons 1974, Trees, shrubs and flowers to know in British Columbia, J. M. Dent & Sons (Canada) Ltd., Toronto, Vancouver). During the flight period of the second generation, the predominant flowering plant is one of several species of knapweed. At an observation site near the Penticton Industrial Park, the knapweed present is diffuse knapweed, *Centaurea diffusa* Lam. This Eurasiatic plant is common in southern British Columbia, and individual plants possess either white or purplish flowers (Frankton & Mulligan 1970, Weeds of Canada, Canada Department of Agriculture Publ. 948).

The Sabuleti Skipper seems to have pioneered this territory successfully, presuming that it truly was absent during the time of previous faunal studies. A rapid flying, small species of skipper, it is difficult to capture. However, it has recently been numerous in and around developed and inhabited areas, making it difficult to overlook. To accomplish a pioneering extension of range, the adults of this species had to be able to find adequate nectar sources during two periods of the growing season. Without a substantial and acceptable nectar source in the fall, second generation adults presumably would starve. Diffuse knapweed is the only abundant nectar source that this skipper has been observed to visit during the fall in the vicinity of Penticton. The presence of this particular species of introduced knapweed, therefore, may have been directly associated with the success of northward pioneering and apparent establishment by this skipper in the dry interior region of British Columbia.

ACKNOWLEDGMENT

I thank the staff of the Lyman Entomological Museum & Research Laboratory, Ste.-Anne-de-Bellevue, Quebec, Canada, for making available work facilities and a reference collection of skippers during June 1976, at which time I determined the identity of the skipper species involved in this study. Voucher specimens have been deposited at that institution.

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LARVAL HIBERNATION OF GEOMETRIDAE IN EASTERN UNITED STATES

Over the past few years, I often encountered partially grown gray stick-like geometrid larvae in autumn well after leaf fall at various localities in Pennsylvania, New Jersey, and Massachusetts. Similarly, such larvae were also found in early spring before leaf development. They were found hanging by silken threads from low limbs or shrubs or on my clothing in fall and crawling actively in spring.

I placed such larvae in small glass jars with tight lids and left them outside for the winter. Absorbent paper was placed in the jar for the larva to rest on. The larvae usually spun silken pads and attached themselves to the paper. The paper was occasionally dampened, often by placing a small amount of melting snow in the jar. The larvae usually survived until spring but most died in March, apparently from desiccation or excessive exposure to sunlight resulting in part from neglect.

The few surviving ones were fed in spring whatever deciduous trees or shrubs that were readily available. In all cases mixtures of *Rosa* spp., *Pyrus* spp., *Prunus*

spp., and *Quercus* spp. formed the bulk of the diet. From seven larvae so fed, the following results were obtained. One of two apparently identical larvae from a small series taken on a sugar maple (*Acer saccharum*) from 28 October–1 November 1974 at Sunderland, Franklin Co., Massachusetts eclosed in late May 1975 as a melanic of a *Hypagyrtis* sp., probably *H. unipunctata* (Haworth). The other larva died in May after the last molt and is preserved at the Peabody Museum of Natural History at Yale University.

Another moth of this genus was reared from a larva found on white oak (*Quercus alba*) at Glendale, Camden Co., New Jersey on 30 November 1975. The larva fed on the usual plants and also molted once in addition to pupation. Eclosion was in June 1976. The specimen is a female of the powdery brown form common in and near the New Jersey Pine Barrens. Many other identical appearing larvae were collected earlier in November in Cape May Co., New Jersey mostly on white oak. These died from mold in February. I tentatively identified the reared moth as *Hypagyrtis pustularia* Hübner.

A larva found on my clothes at Leverett, Franklin Co., Massachusetts 10 November 1973 eclosed the following May as *Protoarmia porcelaria* Guenée. The larva molted once or twice before the pupal molt. It fed in the spring on all of the food plants mentioned. A similar, but more mature larva was found on 25 March 1974 at Batsto, Burlington Co., New Jersey. It was crawling on the twigs of *Leucothoe racemosa* on which the flower racemes were just beginning to grow. These proved to be suitable as food in the laboratory. This larva was parasitized by a tachinid, and its identity was not definitely established.

On 22 April 1974 large gray geometrid larva with short lateral filaments was found on an apple limb at Amherst, Massachusetts. The tree had partially expanded leaves at the time, which were the bulk of the diet of this larva in the laboratory. It eclosed in late May as a *Campaea perlata* Guenée. It did not molt prior to pupation.

Finally, on 20 April 1975 a large, rather slender gray larva with a protuberance on one thoracic segment was found crawling in a blueberry (*Vaccinium vacillans*) patch on the barrens at Batsto, New Jersey. The spring was quite late, and the only plants with any new growth in the immediate area were *Leucothoe racemosa*, whose racemes had partially expanded in late February. This larva was reared to adult, chiefly on *Pyrus* spp. *Prunus serotina* and *Vaccinium corymbosum* were also offered and eaten freely. It molted once. The moth eclosed very late in May as *Euchlaena astylusaria* Walker, a female of the tan form.

Unfortunately, detailed descriptions are not available for the above larvae. All were marked solely with gray, black, and brownish shades. All rested in the typical stick-mimicking posture of many Geometridae.

Besides the larval hibernation, I have noticed another similarity between these species, namely that all have two generations in the above areas, and adults of the spring flight period are larger in size than those of the later emergence. This is especially pronounced in females of *Campaea perlata*. It seems likely that this phenomenon is the direct result of feeding on superior quality spring foliage.

DALE F. SCHWEITZER, *Peabody Museum of Natural History, Yale University, New Haven, Connecticut 06520.*

NOTES AND NEWS

Recent Letters

Dear Dr. Godfrey:

I noted with great interest Dr. Ferris's review of *The Butterflies of North America* by William H. Howe in the recent issue of the *Journal* (vol. 30(2): 138-143). As a devoted collector and student of Holarctic Rhopalocera, I purchased the volume shortly after it appeared, although strong misgivings had been expressed to me by several American friends who, like Dr. Ferris, are to be considered leading professional lepidopterists. As far as I can judge (from collecting Nearctic butterflies only during the first six and most inexperienced years of my 30 as a lepidopterist), their and Dr. Ferris's criticisms are beyond dispute and extremely well-founded.

In very large part the shortcomings of this volume could have been avoided; rather few seem to be attributable to lax editorship and the inevitable unevenness that results from the varying competence of 21 contributors. In a particular field where I am better informed (worldwide *Parnassiinae* being one of my areas of specialization), Dr. Ferris's judgment, though basically sound, has perhaps been more severe than necessary. The current status of *Parnassius Latreille* is so totally chaotic the world over, due to hopeless oversplitting, that Jon and Sigrid Shepard have understandably and even properly gone in for some solid "lumping." Almost undoubtedly they have overdone this. But, like most workers in this group, they have uncritically accepted most of the voluminous work of the two most recent authorities among Parnassiologists, F. Bryk and C. Eisner, who are heavily responsible for the oversplitting; for instance, by now 200 odd subspecies of Palaearctic *P. apollo* L. have been described.

Undoubtedly, however, Dr. Ferris's strictures must be considered as entirely fair on Howe's book as a whole, and we are left with the problem of making the best of it. I feel strongly that we cannot content ourselves with criticism. For most of us, the book has been too heavy a personal investment, and, much more important, it is likely to remain the only major modern work in print on Nearctic Rhopalocera for amateur and professional alike. Nor, unfortunately, do I believe that there will soon be a new edition in which errors could be corrected and omissions rectified. Admittedly, this is a mere guess, for the present volume does not carry any indication of how large an edition was printed; but in view of its bulk, high cost, and inadequacies, the present edition seems unlikely to be exhausted soon and replaced by a new one. Conditions are undoubtedly very different for the highly portable, inexpensive, highly praised, and by now well-established *Field Guides* on butterflies. These, deservedly, sell extremely well—often even getting into a publisher's best-seller list—and therefore run fairly rapidly through several editions.

Thus, Klotz's superb, even uniquely excellent, *Field Guide to the Butterflies of North America, East of the Great Plains* was, and perhaps even still is, a distinct publishing success, though probably not so great as that of Roger Tory Peterson's *Field Guide to the Birds*, which initiated the series, and which, as the Chief Editor of Houghton Mifflin told me in the late forties, had become the best-selling book in American publishing history, after the *Bible*. Dr. Higgins told me when his very good *Field Guide to the Butterflies of Britain and Europe* first appeared that the British publishing house had run off 400,000 (sic!) copies of the color plates to provide for English and foreign language editions. The newest English edition, just out, is thus the *third* in six years. It is a sad reflection, incidentally, that the color plates in Higgins & Riley, which costs less than one-fifth of the Howe book, should be of greatly superior quality, and life-size to scale throughout.

Therefore, I wish to suggest that the Lepidopterists' Society assume the burden and responsibility of raising the value of Howe's book. To begin with, and taking

Dr. Ferris's review as a point of departure, I recommend that a succinct, page by page, *corrections and addenda* to Howe be published in the *Journal*, quite particularly bringing the status of subspecific taxa in the various groups up to date. If Dr. Ferris cannot be persuaded to undertake this task, it should not be too difficult for the Editorial Board of the *Journal* to appoint a panel of experts for it, perhaps including at least some of the specialists who contributed to the Howe volume. Thereafter the *Journal* might publish at regular (annual?) intervals, or as the number of discoveries warrants, a brief annotated list of *addenda* that will keep the book up to date. Society members may recall that early in its history the *News*, and then the *Journal*, published regularly a worldwide section called "Recent Literature on Lepidoptera." This highly ambitious and most valuable service, which provided brief abstracts of *all* new lepidoptera literature, was discontinued with vol. 20, no. 2, in 1966, no doubt because it proved too space-consuming for the publication and too time-consuming for the contributors. Although the Society is happily and successfully international, still, its area of greatest expertise and prime scientific responsibility, as well as the main interest of most of its readers, remains the Nearctic. The service of bringing Howe's volume regularly up to date would therefore, on a more manageable and modest scale, resume the abstracting service of earlier times.

Nor is this entirely an innovation for the *Journal*. Cyril F. dos Passos himself published *addenda and corrigenda* to his *Synonymic List of the Nearctic Rhopalocera* (1964) in the *Journal* (19: 192; 23: 115-125; 24: 26-38). This uniquely valuable and excellent work has thus maintained its great value, and it is to be hoped that the *Journal* will continue to publish *addenda* for the new taxa described. Conceivably, the *Journal* editors may be able to publish such additions to either of the works in such a form that they can be readily inserted into the individual owner's copy, selling such *separata* for a reasonably low charge. But even failing this, one can readily bring one's own copy up to date by making marginal notes or, even better, by interleaving the volume (small and thin interleaf sheets, gummed along one edge, are available for just such purpose at many university bookstores).

HANS J. EPSTEIN

ED. NOTE: Mr. Epstein's comments and suggestions regarding *The Butterflies of North America* are most notable and challenging. I too am interested in the accuracy of all lepidopterological information. However, the responsibility for rectifying mistakes in non-Society publications rests squarely on the shoulders of their publishers, editors, and authors. With the exception of the following letter by Dr. Ferris, I suggest that any additional comments and corrections be sent directly to the author(s) of the book in question. They may then use them more advantageously for compiling an *Addenda et Corrigenda* to be published either in the *Journal* or elsewhere than if the Society was to take the initiative.

G. L. GODFREY

Dear Dr. Godfrey:

Regarding my recent review of Howe's *The Butterflies of North America* (J. Lepid. Soc. 30(2): 138-143, 1976), Mr. H. A. Freeman has kindly pointed out two oversights on my part. The chromosome number of *Megathymus coloradensis* is 27 and that of *M. yuccae* is 26. Thus two distinct species are involved and Killian Roeber, who prepared this section of the book, was in error in placing *coloradensis* as a subspecies of *yuccae*.

In the *Agathymus* section, *chisosensis* was placed as a subspecies of *neumoegeni*. *A. chisosensis* belongs to a different species group as its chromosome count is 18 while that of *neumoegeni* is 10.

Partial chromosome numbers of the Megathymidae are given in Freeman's review of the family (J. Lepid. Soc. Supp. 1, 23: 1-59, 1969).

CLIFFORD D. FERRIS

Dear Dr. Godfrey,

With reference to the note, "Aberrant *Chlosyne lacinia* Nymphalidae) from central Texas" (Neck 1975, J. Lepid. Soc. 29: 259): if Mr. Neck examines the forelegs of his abdomen-less specimen, he should have little difficulty in determining its sex. The fore-legs in both sexes of the Nymphalidae are useless for walking, but that of the female bears some likeness to a leg, whilst that of the male has degenerated into little more than a brush.

American authors seem strangely reluctant to mention the use of the fore-leg as a means of sexing butterflies. British authors, using any form of key for classification, invariably mention the condition of the fore-leg as one of the basic couplets Imms (*A General Text Book of Entomology*) . . .

D. G. SEVASTOPULO

Dear Sir:

The suggestion by Professor Ehrlich (vol. 30, p. 149) that *P. xuthus* may have reached Hawaii by natural dispersal may well be correct, although I think the intervention of some form of human agency is more probable. However, the analogy of the Lycaenid *Vaga* is misleading. "*Vaga*" *ogasawaraensis* of the Bonin Is. is a *Celastrina* species very closely allied to, and clearly derived from, *C. sugitanii* (Matsumura) of Japan, which in turn is closely allied to *C. argiolus* (L.). None of these species are at all closely allied to the Hawaiian *Vaga blackburni*, which, to judge by its male genitalia, has its nearest relatives in a group of Papuan species which includes "*Candalides*" *meeki* Bethune-Baker, "*Holochila*" *owgarra* Bethune-Baker, "*Lycaenopsis*" *manokwariensis* Joicey & Noakes, "*L.*" *pullus* Joicey & Noakes and several other unnamed species, for which a new genus is required and will be named in the review of the *Lycaenopsis* section currently being undertaken by Akito Kawazoe and myself.

It is certain that the ancestor of *Vaga* must have reached Hawaii by transoceanic dispersal, but it seems likely that the route followed was a more southerly one than that taken by *P. xuthus*.

L. N. ELIOT

Corrigendum

The species name *myrtale* was misspelled "*myratle*" in the title of Dr. Ichiro Nakamura's recent article (J. Lepid. Soc. 30: 305-309). I thank Dr. Nakamura for pointing out my error.

Editor

OBITUARY



EUGENE S. MILJANOWSKI (1908–1976)

Dr. Eugene S. [Yevgeniy Semionovitch] Miljanowski died of a heart attack on 29 May 1976 in his home in Sukhumi, where he spent the last 43 years of his life. He was one of the most remarkable persons in Soviet lepidopterology and was widely known for his important contributions to the faunistic study and zoogeographic interpretation of the macrolepidoptera of the Caucasus, especially in the Abkhazian Autonomous Soviet Socialist Republic.

Eugene S. Miljanowski was born on 12 January 1908 in Warsaw, into the family of a Russian officer. In 1916 his family settled in Poltava (Ukraine), where he took his first steps in his profession and life-long passion—entomology. It is here he met Alexandr S. Danilevski, and the ensuing friendship, first based on a common interest in butterflies and moths, persisted till Danilevski's death in 1969 (see A. Diakonoff 1970, *J. Lepid. Soc.* 24: 70–72). After finishing high school and Horticultural Technical School in 1927, he was appointed in the Poltava Agricultural Experiment Station as an assistant with the special task to study the macrolepidopteran fauna of the Poltava district. In 1930–1933 he co-operated with the Lubny Medical and Etheric-Oil Plant Experiment Station. From 1933 on, his permanent residence spot was Sukhumi, where he was appointed as an assistant and then advanced to the head position of the Plant Protection Division, Sukhumi Etheric-Oil Plants Research Station. He worked there until his retirement in 1976, several months before his death. Starting in 1946 he was pluralistically employed at the Natural History Division, Abkhazian Lore Museum, where his efforts resulted in a remarkable increase in the collections and scientific level of the staff activity.

Because of strong myopia he was not fit for military service and was unable to take a direct part in World War II. At this time he studied the possible use of etheric oils and parts of etheric plants for wound cures. This research resulted in obtaining some original, therapeutically active preparations for wound microflora control and supporting quick healing of wounds. For efforts in this field he was awarded the medals "For Defence of Caucasus" (1945) and "For Valiant Labor in the Great Patriotic War" (1947).

His decision to leave Ukraine for Caucasus he explained by the fact that Western Caucasus and its Black Sea Coast in particular were then unstudied by lepidopterists so he found this area far more worthy of study and discovery-promising. Alone, sometimes in company with visiting entomologists, or as a member of botanical, zoo-

logical and geological expeditions he collected in practically all accessible—and often not so accessible—parts of Abkhazia, from the swampy lowlands to the high montane areas. He was really tireless in field work. During the weeks, after days of hard climbing and walking he was still able to spend nights collecting with a light trap, having only an hour or two of drowsiness with head on sleeve. In the field he ignored comfort and his luggage was limited to a minimal *omnia mea mecum porto*. The most important results of these year-to-year excursions was the development of the most complete regional collection of butterflies and moths that ever existed in Caucasus. This was bequeathed to the Zoological Institute of the U.S.S.R. Academy of Sciences, Leningrad.

Miljanowski published more than 50 scientific articles on the macrolepidoptera of Abkhazia and other parts of the Caucasus, and more than one hundred papers (including popular articles) on plant protection, nature conservation (with special reference to insect protection), insect behavior and ecology, botany, herpetology, batrachology, and speleology. For the past 10 years he was President of the Speleology Section at the Sukhumi Tourist Club. He was a man with a wide range of interests in different aspects of human activity. He was an expert in Ancient Greek mythology, and often recited his own hexameters on recent affairs where Hellenistic persons were employed. His second passion was classic music, especially opera. He collected many hundreds of records, and I often heard him singing his favorite parts of operas in the field. He was always ready to teach. As a man of generous soul he was easy to contact, and his home was always filled with people.

Superficially Miljanowski represented a naturalist of an older generation professing the Staudinger-Seitz taxonomic doctrine. At the same time, under this "Tory" mask, a man of unordinary approach and world vision was covered. One example will depict his original way of thinking. A puzzling peculiarity of the Black Sea coast of the Caucasus and the Crimea as a habitat is their relative faunal wretchedness, though these areas with their 'subtropical' climate would seem to be richer in Lepidoptera than the adjoining mountains and plains of Ciscaucasia. Contrary to recognized theory of geological-geographical isolation of N. J. Kuznetsov (1929), Miljanowski proved the ecological background of this phenomenon. The reason appeared to be surprisingly simple: these coastal areas cannot be colonized by boreal species because they are too warm for their hibernation and winter diapause (the lack of freezing); on the other hand, relatively low winter temperatures prevent colonization of the coast by southern species (Miljanowski 1956, *Zool. Journ. (Moscow)* 35: 1170-1176).

A central position in his scientific work occupies "Macrolepidoptera of Abkhazia: Ecology and Economic Importance" which he defended in 1961 as a doctoral thesis in Tbilisi Agricultural Institute. Together with more recent publications, this work promises to be a concise guide to the butterflies and moths of Abkhazia and adjoining areas of Georgia and Russia, and it may be hoped that in the near future it will be prepared for publication. It will be the best possible monument to the man whose knowledge, advice and suggestions were widely used by his numerous pupils, colleagues, and friends. His name will never be omitted in the Caucasian lepidopterology and he will persist in our memory.

YURI P. NEKRUTENKO, *Ukrainian Institute for Plant Protection, 252627 Kiev 127, Ukraine, U.S.S.R.*

BOOK REVIEWS

MOTHS OF SOUTHERN AFRICA, by E. C. G. Pinhey. 1975. Tafelberg Publishers Ltd., 28 Wales Street, Cape Town, South Africa, 273 p., 19 figures (line drawings), 63 color plates. Price \$35.95 (U.S.).

At the risk of offending the ardent rhopalocerists who have grown accustomed in recent years to the availability of exquisite butterfly books, complete with color plates, from nearly all corners of the world, it is refreshing to see, occasionally, a regionalized treatment of moths. E. C. G. Pinhey's *Moths of Southern Africa* is designed to stimulate interest in the moth fauna of southern Africa and is a broad introduction to the subject, not a definitive treatment of this entire fauna. Pinhey includes 1181 of the more common, colorful, or economically important moth species, mainly from the defined region, in the color plates (plus a line drawing of an additional species) and provides brief descriptions of them in the text. A hostplant index, glossary, substantial number of cited references, and line drawings supplement the color plates and textual information.

Using a balance of technical and nontechnical terminology, Pinhey introduces the moths by reviewing their basic morphological, ecological, and behavioral characteristics. The written portion of the introduction certainly should stir the interests of budding lepidopterists. However, I was surprised to find virtually no discussion on the genitalia that are so very useful in identification and classification, yet two pages of space are devoted to line drawings of these important structures.

Taken in their entirety, the line drawings, which make up a substantial proportion of the introductory material, are satisfactory. The beginning student might occasionally be confused by the structural terminology in the text and symbols used in some figures because a few problems are caused by combinations of printing errors and inconsistencies in symbol application. For example, Figure 5 is referred to as "fig. 3" on page 7, and "ar," the symbol for areole in the figure legend, is "Ar" in Figures 5 c, e, and f. In other figures "RS" denotes both the reniform stigma and the radial sector.

The author has chapters on "Collecting and preparing insects" and "Identification and classification." The former is rather brief, though references are provided that may be consulted for information on specific procedures. The latter also is brief, but interestingly written for its intended audience. However, the identification key to suborders and superfamilies ideally belongs here, not in the subsequent chapter entitled "Swifts and Longhorns"! Pinhey should have given figure references in the couplets of his keys, especially since his book is meant to interest and aid persons who are not professional and/or experienced lepidopterists, not discourage them. The remaining keys generally go to the family level (a few extend to the subfamily level)—beyond that the color figures and brief species accounts serve as the identification aids.

The printing quality of the color plates is excellent with the exception of a few cases where the colors of the plate backgrounds and moths are so similar that the specimens are scarcely visible. There is a problem with the organization of the plates that lessens their effectiveness and utility for identifying specimens. Namely, families, congeners, and, in some cases, the same species frequently are depicted on different plates separated by several pages of text and other plates. For example, the Limacodidae occur on plates 1, 2, 5, and 7 and adult Lasiocampidae on plates 1, 22, 24–26, and 29–30. The author should have spent less time coining almost useless, common names and more time on the overall organization of his book and embellishment of the introductory chapters.

Considering the large number of species and color plates in *Moths of Southern Africa*, the price is not unreasonable. The book should prove rather useful to those

for whom it was designed. The book's true value will be realized if a host of minds is inspired to continue the study of heterocerous species in southern Africa or elsewhere.

GEORGE L. GODFREY, *Section of Faunistic Surveys and Insect Identification, Illinois Natural History Survey, Natural Resources Building, Urbana, Illinois 61801.*

LEGION OF NIGHT—THE UNDERWING MOTHS, by Theodore D. Sargent. 1976. University of Massachusetts Press, Amherst, Massachusetts, 222 + xiii p., 8 color plates. Price \$15.00 (U.S.).

My introduction to the underwing moths was dramatic. As a high school student I had just taken up collecting Lepidoptera and had read with great interest the article on "sugaring" in W. J. Holland's *The Moth Book*. I had just sugared a path along a road in the northern Wisconsin forest. In the fading light of the evening I had discerned the outline of a beautifully banded underwing moth. I was forever hooked on the *Catocala*.

So it was with unexpected pleasure that I read Theodore D. Sargent's *Legion of Night—The Underwing Moths*. He has captured the romance of these unusual and beautiful insects.

Statistically the book contains two hundred twenty-two pages, and has eight colored plates depicting one hundred twenty-six specimens in color consisting of seventy-one species of underwing moths found in the eastern United States. In addition there are numerous black and white colored plates and many fine drawings.

Sargent's book gives a complete survey of the *Catocala* of the eastern United States, a summary of the current biological information on these species, and introduction to the scientific investigations which are being conducted on these moths.

The species accounts give the range, within the scope of the geographical area covered by this book, the seasonal occurrence, larval food plants, and the interesting behavioral aspects of the adults of each species. In this respect it is quite unique. None of the work done on the *Catocala* in the past has gone into these aspects. In this respect it is most helpful to the field entomologist. So few works on Lepidoptera seem to be concerned with this aspect of collecting. Every species of *Catocala* one might encounter in the eastern United States is covered completely.

Dr. Sargent gives an interesting history of the entomologists who described the species found in the area or wrote about these moths in his chapter "Of Men and Names." Thus, we get an insight into the entomological lives of such men as Coleman T. Robinson, Augustus Radcliffe Grote, Achille Guenée, Ferdinand Heinrich, Herman Strecker, William Henry Edwards, the Reverend George D. Hulst, and Francis Walker. The book contains excerpts from the published letters of several of these entomologists, particularly Strecker, Grote, and Hulst. None of these men held the others in any great esteem, and their sniping at each other makes for interesting reading. Apparently they were unaware of the laws on libel and slander. In any event there is no record of any civil actions arising out of these feuds.

Each species is accurately described, and similar species distinguished. The relative abundance or scarcity of the particular species is fully discussed. Of great importance to the collector is something about the larval habits and the habits of the adults in coming to light or to bait, or to various types of traps. The book contains much statistical material on abundance of the various species and something about the predators of the larva and adults, particularly bird and bat damage to the adults.

I would make only one criticism of the book. On the theory nobody is perfect, I would liked to have seen the plates with a lighter background. Since so many of

the *Catocala* have at least dark forewings, the specimens do not stand out against the black background, and in this respect I think a paler background would have produced much better colored plates.

In any event this is a most worthwhile contribution to the science of Lepidoptera. This volume should be in the library of every moth collector.

WILLIAM E. SIEKER, 119 Monona Avenue, Madison, Wisconsin 53703.

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NOTICE TO CONTRIBUTORS

Contributions to the *Journal* may deal with any aspect of the collection and study of Lepidoptera. Contributors should prepare manuscripts according to the following instructions.

Text: Manuscripts should be submitted in *duplicate*, and must be typewritten, *entirely double-spaced*, employing wide margins, on one side only of white, $8\frac{1}{2} \times 11$ inch paper. Titles should be explicit and descriptive of the article's content, including the family name of the subject, but must be kept as short as possible. The first mention of a plant or animal in the text should include the *full scientific name*, with *authors* of zoological names. Insect measurements should be given in *metric units*; times should be given in terms of the *24-hour clock* (e.g. 0930, not 9:30 AM). Underline only where *italics* are intended. References to footnotes should be numbered consecutively, and the footnotes typed on a separate sheet.

Literature Cited: References in the text of articles should be given as, Sheppard (1959) or (Sheppard, 1959, 1961a, 1961b) and all must be listed alphabetically under the heading LITERATURE CITED, in the following format:

SHEPPARD, P. M. 1959. Natural selection and heredity. 2nd. ed. Hutchinson, London. 209 p.

——— 1961a. Some contributions to population genetics resulting from the study of the Lepidoptera. *Adv. Genet.* 10: 165–216.

In the case of general notes, references should be given in the text as, Sheppard (1961, *Adv. Genet.* 10: 165–216) or (Sheppard 1961, *Sym. Roy. Entomol. Soc. London* 1: 23–30).

Illustrations: All photographs and drawings should be mounted on stiff, *white* backing, arranged in the desired format, allowing (with particular regard to lettering) for reduction to their final width (usually $4\frac{1}{2}$ inches). Illustrations larger than $8\frac{1}{2} \times 11$ inches are not acceptable and should be reduced photographically to that size or smaller. The author's name, figure numbers as cited in the text, and an indication of the article's title should be printed *on the back* of each mounted plate. Figures, both line drawings and halftones (photographs), should be numbered consecutively in Arabic numerals. The term "plate" should not be employed. *Figure legends* must be typewritten, double-spaced, *on a separate sheet* (not attached to the illustrations), headed EXPLANATION OF FIGURES, with a separate paragraph devoted to each page of illustrations.

Tables: Tables should be numbered consecutively in Arabic numerals. Headings for tables should not be capitalized. Tabular material should be kept to a minimum and must be typed *on separate sheets*, and placed following the main text, with the approximate desired position indicated in the text. Vertical rules should be avoided.

Proofs: The edited manuscript and galley proofs will be mailed to the author for correction of printer's errors. Excessive author's changes at this time will be charged to authors at the rate of 75¢ per line. A purchase order for *reprints* will accompany the proofs.

Correspondence: Address all matters relating to the *Journal* to the editor. Short manuscripts such as new state records, current events, and notices should be sent to the editor of the *News*: Ron Leuschner, 1900 John Street, Manhattan Beach, California 90266.

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Memoirs of the Lepidopterists' Society, No. 1 (Feb. 1964) A SYNONYMIC LIST OF THE NEARCTIC RHOPALOCERA

by CYRIL F. DOS PASSOS

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IMMATURE STAGES AND ECOLOGICAL OBSERVATIONS OF *EOPARARGYRACTIS PLEVIE* (PYRALIDAE: NYMPHULINAE)

SANDY B. FIANCE¹ AND ROBERT E. MOELLER²

Eoparargyractis plevie was described by Dyar (1917) from an adult female. Lange (1956) hypothesized that the unknown larvae in this genus feed on the rock-encrusting periphyton of small lakes. Our observations from Mirror Lake, New Hampshire, indicate that, in fact, the larvae of *E. plevie* feed on several species of aquatic macrophytes.

Collections of the plant species *Lobelia dortmanna* L., *Isoetes tuckermanni* A. Br., and *I. muricata* Dur. in 1974 and 1975 frequently included larvae of this species. Leaves of infested macrophytes were usually damaged, suggesting that the larvae were feeding on the macrophytes themselves, rather than on any sparse periphyton they might have supported. Behavioral observations in the laboratory confirmed this interpretation. Apparently there are no previous reports of insects feeding on these species.

The following report (1) describes the previously unknown larva and pupa of *Eoparargyractis plevie*; (2) establishes that the pupal stage is passed underwater and possesses what may be a stridulatory apparatus; (3) provides the first information on larval feeding habits in the genus; and (4) is the first discussion of insect feeding on aquatic rosette plants.

Description of Immature Stages

Larva: Head (Fig. 4C) 0.96 mm wide. Right mandible (Fig. 3C) with 5 cusps, slightly curved along outer margin and with a simple peg-like tooth basal to the first cusp. Ventral margin of mandible with a broadly produced flange having two setae inserted at its base, the proximal one less than $\frac{1}{2}$ length of the distal. Labrum (Fig. 2) with three highly modified setae on each side of midline (Fig. 3A, 3B). Head capsule translucent yellow, pigmented black only along adfrontal region and around ocelli. Total body length 11 mm. Prothoracic coxae nearly

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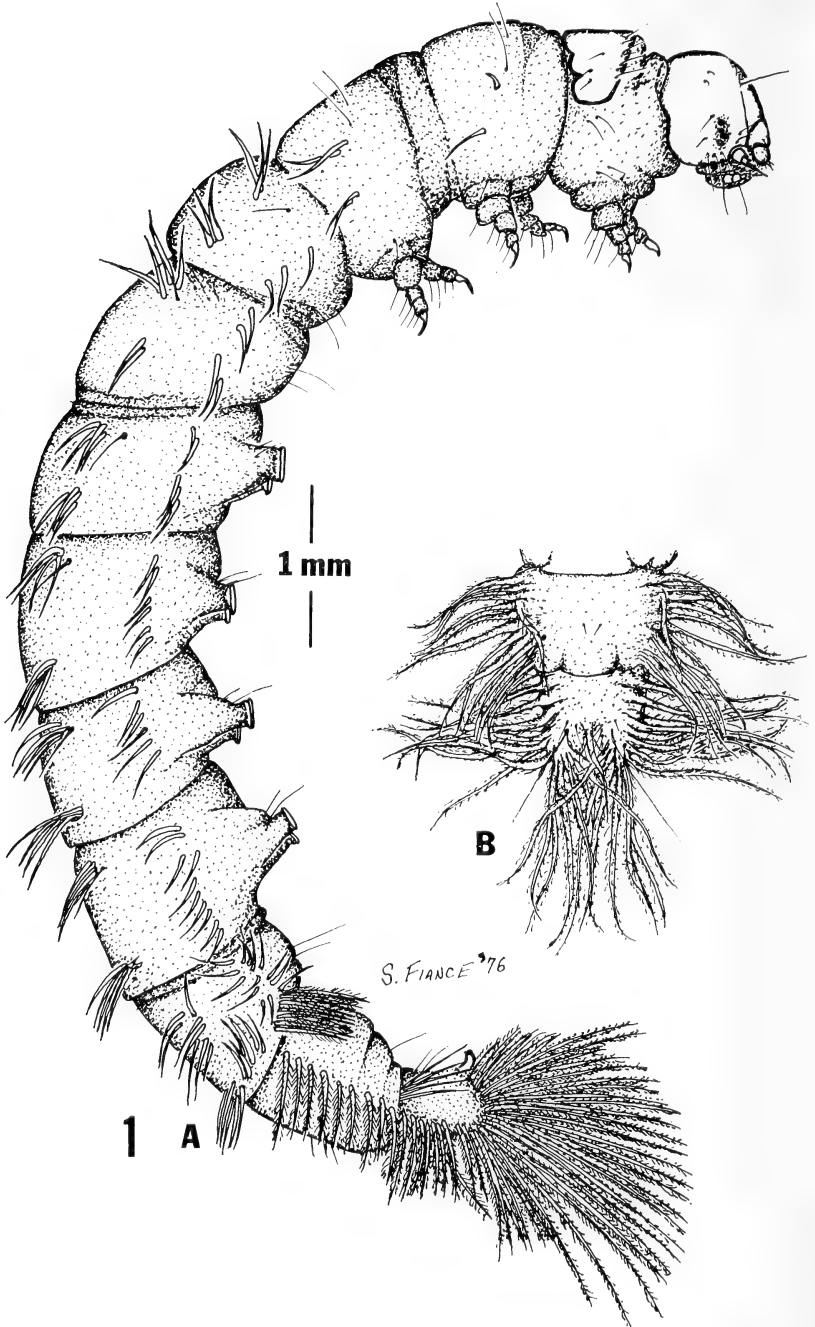


Fig. 1. Mature larva of *E. plevie*: A, habitus, lateral view; B, dorsal view of terminal abdominal segments.

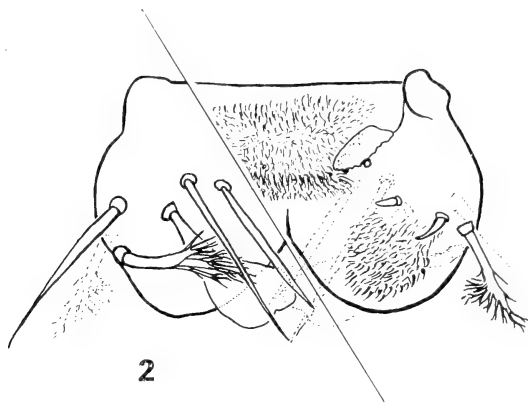


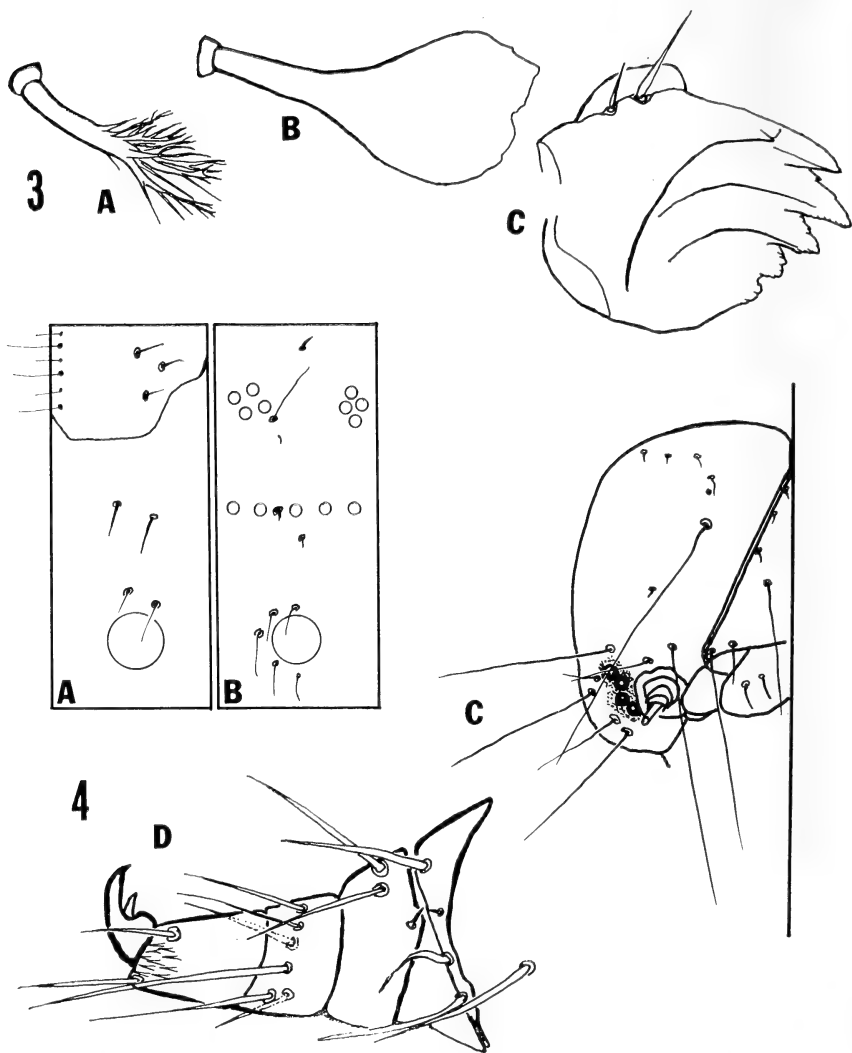
Fig. 2. Labrum of larva of *E. plevie* (outer surface to the left and inner surface to the right of diagonal line).

contiguous; metathoracic coxae widely separated. Dorsal abdominal setae $\frac{3}{4}$ to equal length of antero-dorsal abdominal gills. Integument spiculate, with coarse, very short setae arising from knob-like projections, setae becoming longer toward caudal end. Setation of head as in Fig. 4C. Integument in living condition unpigmented, light green interior showing through. Gills as in Fig. 1, unbranched with one exception, or arising from a common base, present on last two thoracic and all abdominal segments. Last gill cluster on margin of tenth abdominal segment having 5 branches. Gills variable in number and exact position, those of segments 8–10 beset with fine hairs around their entire periphery, and forming a flap-like extension of the last abdominal segment (Fig. 1B). Crochets a uniserial biordinal circle on prolegs 1–4 and a uniserial biordinal mesoserries on anal proleg. Setation of first thoracic and third abdominal segments in Figs. 4A & B respectively.

Material examined: NEW HAMPSHIRE, Grafton Co.: W. Thornton, Mirror Lake; 8 September 1975, Robert E. Moeller; 10 larvae killed immediately; same locality: 22 October, 1 larva reared, killed 11 December 1975. NEW YORK, Herkimer Co.: Webb Township, Upper Sylvan Pond; 10 June 1975, Leo M. Demong; 3 larvae. NEW YORK, Herkimer Co.: Webb Township, Panther Lake; 8 October 1975, Leo M. Demong; 2 larvae.

Pupa: Cocoon (Fig. 7) spun on leaf at rosette base (*Lobelia dortmanna*), often ornamented with bits of vegetation. Inner silken sheath complete on all sides, no gap or holes along leaf. Total length of pupa 6–7 mm. Unpigmented. Four respiratory tubercles on abdominal segments 2 & 3 (Fig. 6A). Cremaster as in Figs. 5B, 6B. Metathoracic tarsi heavily sclerotized, each bearing a long tooth at tip (Fig. 5A). Two series of raised ridges present on abdominal sternites closest to tips of metathoracic legs (Fig. 5B).

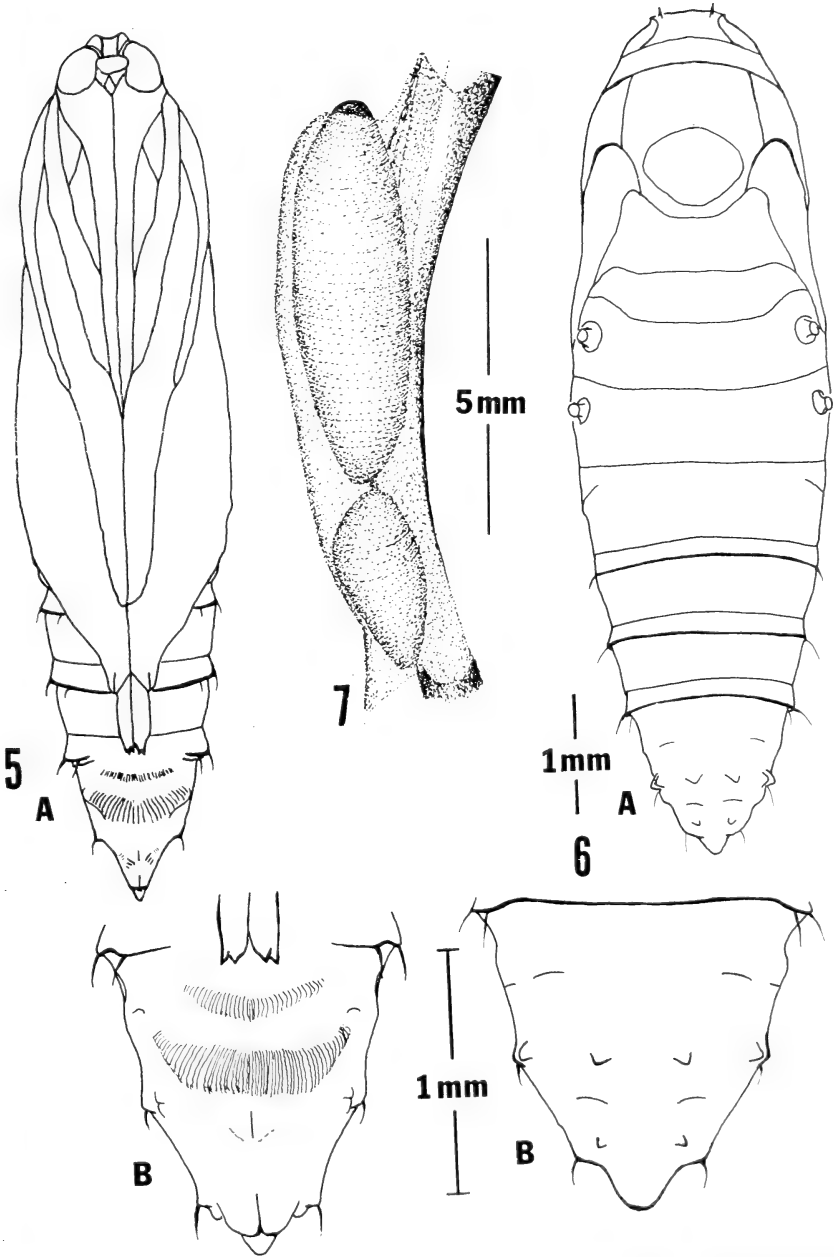
Hinton (1948) reviewed a number of mechanisms of sound production in lepidopterous pupae. He concluded that stridulation probably frightens predators and parasites, thus serving as a defense mechanism. According to Hinton, an elongated proboscis is rubbed against raised ridges of the fifth abdominal sternite producing a hissing sound in *Gangara thyrasis* F. *E. plevie* has a similar morphological arrangement (Fig. 5). Although sound production by the pupae of *E. plevie* has not been demonstrated, stridulation by this species is suggested by the two series of raised ridges on the abdominal sternites near the heavily sclerotized teeth at the tip of the metathoracic tarsi. In view of the aquatic habit of the pupae of



Figs. 3, 4. Larva of *E. plevie*: 3A & B, enlarged views of modified setae borne on labrum; C, view of inner surface of right mandible. 4, setation diagrams of first thoracic segment (A) and third abdominal segment with small circles indicating positions of gills (B); frontal view of right half of head, excluding modified setae of labrum (C); setation of left prothoracic leg (D).

E. plevie, an alternative hypothesis involving the defense of localized resources (a rosette) seems in order.

Material examined: NEW HAMPSHIRE, Grafton Co.: W. Thornton, Mirror Lake; larvae collected October and November 1975, Robert E. Moeller. Reared on *Lobelia dortmanna*, 5 cocoons recovered January 1976 containing 4 pupal exuvia, 1 pupa.



Figs. 5-7. Pupal stage of *E. plevie*: 5, ventral view of pupa, habitus (A) and cremaster (B); 6, dorsal view of pupa, habitus (A) and cremaster (B); 7, cocoon attached to leaf of *Lobelia dortmanna*, containing pupa and exuvia of last larval instar.

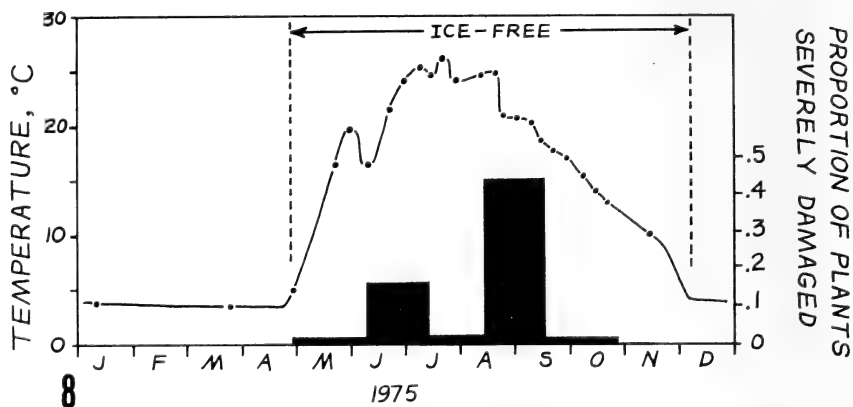


Fig. 8. Temperature during 1975 at a depth of 2 m in Mirror Lake, New Hampshire (curve) and temporal incidence of severely damaged, dead, or vanished *Lobelia dortmanna* as a proportion of the experimental population (histogram).

Distribution: Maine, Massachusetts, Nova Scotia, Quebec; NEW RECORDS from New Hampshire and New York. Larval and pupal voucher specimens are deposited at the Canadian National Collection and the Cornell University Collection.

Ecological Observations

In Mirror Lake, New Hampshire, larvae are frequently encountered during late summer on *Lobelia dortmanna*, *Isoetes tuckermanni*, and *I. muricata*. These small (1–5 cm high) plants consist of a rosette of stiff, narrow leaves at the base of which the larvae construct a protective purse of silk and detritus. Larvae cut through and ingest the thin epidermis that surrounds the intercellular air spaces of the largely hollow leaves. Damage to the plant can be severe; badly injured leaves die and separate from the plant, and growing leaves may be deformed by the silken tube attachments. Defoliated plants have been encountered, as well as decayed plants that had died as a result of the defoliation. Although no more than a single larva has been found on any *Lobelia dortmanna* plant, several may occur on a single rosette of *Isoetes tuckermanni*. Muskrats (Gaevskaya, 1966) and ducks (Fassett, 1969) have been reported to feed on rosette species, and muskrats occasionally feed on *L. dortmanna* and other plant species in Mirror Lake. *E. plevie* seems to be the first reported insect herbivore on these plants.

The period of most intensive feeding in Mirror Lake was estimated from a plant growth experiment carried out on *Lobelia dortmanna* during the summer of 1975. Seventy-five individual rosettes over a depth range of 0.5–1.5 m were marked, and the appearance of new leaves was followed

at 4-week intervals over the growing season (May–September). Fig. 8 (histogram) indicates the temporal incidence of severely damaged, dead, or vanished plants. Much of this mortality was due to *E. plevie*, but additional factors cannot be discounted. The early summer peak probably corresponds to feeding of late-instar larvae before pupation, and the late summer peak with feeding of the newly hatched larvae of the next generation. Although these results suggest a very great impact of the insect on the host plant population, it appears that the experimental plants suffered heavier infestation than the population as whole, perhaps as the result of greater spacing between experimental plants.

Mirror Lake contains approximately 20 species of aquatic macrophytes (Moeller, 1975). Larvae of *E. plevie* have been found on the three species already listed, and could occur on others that have been less intensively examined. They do not occur on *Utricularia purpurea* Walt., *Nuphar variegatum* Engelm., or *Nitella flexilis* (L.) Ag. The known distribution of *E. plevie* (Munroe, 1972) coincides with regions of soft-water, oligotrophic or dystrophic lakes in which *Lobelia dortmanna* and *Isoetes* species are common, and to which many of them, including *L. dortmanna*, are restricted (Fassett, 1930; Swindale & Curtis, 1957). Larvae of *E. plevie* from New York came from an oligotrophic Adirondack lake where *Isoetes* sp. is abundant. This insect's distribution may be determined by the restriction of its host plants, *Lobelia* and *Isoetes*, and possibly other rosette plants, to unproductive lakes in regions of granitic bedrock (northern New England and eastern Canada) or sandy outwash (Cape Cod and Martha's Vineyard).

Life Cycle

Larvae have been collected in Mirror Lake from August through mid-November. The absence of plant damage after the middle of September indicates that the larvae have become quiescent, but if disturbed, they will move about. Forbes (1923) described overwintering larvae in the closely related genera *Nymphula* and *Parargyractis*. *E. plevie* also overwinters as a larva. The pupal stage is passed underwater, cocoons being constructed at the bases of *Lobelia dortmanna* rosettes in laboratory-reared specimens. Pupation and emergence have not yet been observed on Mirror Lake, but the observed pattern of damage to *L. dortmanna* is consistent with the July–August flight period known elsewhere (Munroe, 1972).

Larvae collected 22 October and reared at 20–25°C on *Lobelia dortmanna* emerged 8 weeks later on about 20 December. Larvae collected 12 November emerged about 10 January, again after about 8 weeks.

These development times are consistent with a flight period of late July if the overwintering larvae resume development above a 16–18°C threshold at the end of May (Fig. 8, showing temperature at a depth of 2 m, representative of the 0.5–3 m recorded range of the insect). The absence of significant new damage to Mirror Lake *L. dortmanna* after mid-September indicates a slowdown in feeding and development below 18–20°C.

ACKNOWLEDGMENTS

A number of our associates at Cornell have provided substantial aid in this publication. Dr. John G. Franclemont generously provided the initial adult determination, constant encouragement and advice and critically read the manuscript. Tim McCabe and Richard Brown contributed many ideas and technical expertise. We are also indebted to Dr. C. O. Berg and Dr. George Eickwort for considerably improving the manuscript and figures. Leo Demong kindly provided larval specimens from upstate New York. We gratefully acknowledge the partial financial assistance of the Department of Entomology, Cornell University and the National Science Foundation through Dr. Gene E. Likens and the Hubbard Brook Ecosystem Project.

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SIX NEW SPECIES OF HESPERIIDAE FROM MEXICO

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During the process of conducting research on the HesperIIDae of Mexico, several undescribed species recently have been found, six of which are described in this article.

***Pyrrhopyge hoffmanni* Freeman, new species**

Figs. 3, 4, 17

Male (Upper side). Primaries black with an orange-yellow spot near base in space 1b, the upper half of the spot is orange and the lower half yellow. There is a circular spot in space 1b situated directly below the spot in space 2. The cell is linear and situated inward from the oval shaped spot in space 2. There is a linear spot in space 3 and another in space 4. The four apical spots form an even curve starting with one in space 6 and extending to space 9. All spots are sordid white. Fringes white, black at end of veins.

Secondaries black, with the outer margin somewhat crenulate. Fringes white, black at ends of veins.

Male (Under side). Primaries black. There is a narrow orange streak in space 1a. In space 1b and the cell near the base there is an orange area. The costa from the base to near mid wing is bright orange. The discal and apical hyaline spots are well developed and are clear white. The veins are somewhat lighter than the ground color.

Secondaries black with a bright orange basal area covering somewhat less than one half of the wing. There is a distinct black cell spot and one specimen has another black spot below the cell spot. There is a narrow black line at the base of the wing. The veins are somewhat lighter than the ground color.

Thorax above black with an orange spot on each side below the head, beneath black and orange striped. Abdomen black above, orange and black striped beneath. Head black, white spotted. Palpi black, with distinct white outer areas and white spotted cheeks. Legs black and orange. Antennae, both shaft and club, solid black.

Wing measurements. Primaries: base to apex, 25 mm; apex to outer angle, 17 mm; outer angle to base, 19 mm. Secondaries: base to end of vein 3, 15 mm; center of costa to anal angle, 18 mm. Total expanse, 48 mm.

Female. Very similar to the male. The only difference is the less crenulate secondaries and the larger size.

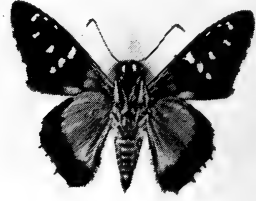
Wing measurements. Primaries: base to apex, 32 mm; apex to outer angle, 22 mm; outer angle to base, 22 mm. Secondaries: base to end of vein 3, 22 mm; center of costa to anal angle, 22 mm. Total expanse, 55 mm.

Type material. Holotype, male, Tenosique, Tabasco, Mexico, 3 September 1962 (E. C. Welling collector), will be placed in the American Museum of Natural History, New York. Allotype, female, Chimalapa, Oaxaca, Mexico, September 1965 (T. Escalante collector), is in my collection. There are three male paratypes from Tenosique, Tabasco, one collected 18 August 1962, one 26 August 1962, and the other 7 September 1962, and one male paratype from Middlesex, Stann Ck. District, British Honduras, 24 March 1965. All paratypes were collected by E. C. Welling.

This new species is named for the late C. C. Hoffmann, who did so much to increase our knowledge of the Mexican Rhopalocera.



1



2



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8

Pyrrhopyge hoffmanni belongs in the *maculosa* group of Evans (1951). His concept of there being but two species in this group is completely in error. Actually with the discovery of *hoffmanni* there are now six species present, four occur in Mexico, *mulleri* Bell, *erythrosticta* Godman & Salvin (Figs. 1 & 2), *hoffmanni* and *araxes* Hewitson and its subspecies *arizonae* Godman & Salvin. *Maculosa* Hewitson and *coxaea* Druce are found in Colombia. *Mulleri*, *erythrosticta*, and *hoffmanni* fly in the same general area in Tabasco, Veracruz and Oaxaca. Besides differences in the genitalia *hoffmanni* can be separated easily from *mulleri* by the following differences: (1) *mulleri* lacks hyaline spots on the primaries; (2) *mulleri* lacks the cell spot on the lower surface of the secondaries which is present in the orange basal area of *hoffmanni*; and (3) *hoffmanni* is slightly smaller than *mulleri*. *Hoffmanni* differs from *erythrosticta* in the following ways: (1) the discal spots on the primaries of *erythrosticta* in spaces 1b, 2, and the cell form a straight line, whereas in *hoffmanni* the spot in space 2 is displaced outward from the other spots, not forming a straight line; (2) the basal orange area on the lower surface of the secondaries is much more extensive in *erythrosticta* covering approximately two thirds of the wing, while in *hoffmanni* it covers less than one half of the wing; (3) there is no cell spot in the orange area of *erythrosticta* which is present in *hoffmanni*; (4) the orange-red spot near the base of the primaries on the upper side in space 1b is solid deep orange-red in *erythrosticta*, while in *hoffmanni* the upper half is orange and the lower half is yellow; and (5) *erythrosticta* lacks the orange spots on the thorax just below the head which are present in *hoffmanni*.

***Epargyreus deleoni* Freeman, new species**

Figs. 5, 6, 18

Male (Upper side). Primaries light brown, with the discal spots yellowish-orange; spot in 1b linear, midway between the outer margin spot in space 2; spot in space 2 broader at the top than bottom, overlapping midway the cell spot; cell spot broader at the top than bottom; spot in space 3 small and linear. There are two minute linear spots over the outer edge of the cell spot. There is one minute apical spot. Basal and discal areas including space 1a heavily overscaled with golden-yellow scales. Costal fold well developed. Fringes yellowish-brown.

Secondaries yellowish-brown, heavily overscaled with golden-yellow scales over

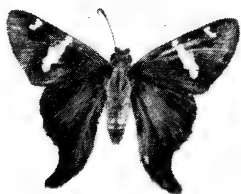
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Figs. 1, 2. *Pyrrhopyge erythrosticta* Godman & Salvin. Male. Middlesex, Stann Ck., Dist., British Honduras, 24 August 1965 (E. C. Welling; H. A. F.).

Figs. 3, 4. *Pyrrhopyge hoffmanni*, n. sp. Holotype, male, Tenosique, Tabasco, Mexico, 3 September (E. C. Welling; A. M. N. H.).

Figs. 5, 6. *Epargyreus deleoni*, n. sp. Holotype, male, X-Can, Quintana Roo, Mexico, 13 June 1969 (E. C. Welling; A. M. N. H.).

Figs. 7, 8. *Typhedanus salas*, n. sp. Holotype, male, Pisté, Yucatan, Mexico, 26 August 1968 (E. C. Welling; A. M. N. H.).



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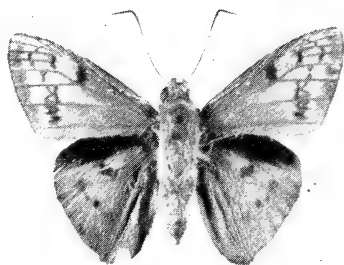
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the basal and discal areas to near the outer margin. Fringes yellowish-brown, brown at ends of the veins.

Male (Under side). Primaries, light brown, with a purplish wash over the apical and outer cellular areas. Space 1a light tan. The hyaline spots are yellowish-brown.

Secondaries dark chocolate brown over basal and discal areas. Outer margin grayish with a purplish sheen. Discal spots narrow, beginning at space 1b and extending in a straight line to space 7. The spot in space 3 extends slightly outward. The spots extending through cell and above, narrow and linear. All spots silvery-white. There is an indistinct band beginning at space 1b and running in an irregular manner just outside the silvery, discal band, terminating at the upper edge of the cell.

Thorax golden-brown above, dark brown beneath. Abdomen golden-brown above, lighter brown beneath, with indistinct segmental striping. Head golden-brown. Palpi chestnut brown. Legs tan. Antennae, shaft light brown above and below, club slightly darker.

Wing measurements. Primaries: base to apex, 27 mm; apex to outer angle, 18 mm; outer angle to base, 17 mm. Secondaries: base to end of vein 3, 15 mm; center of costa to anal angle, 21 mm. Total expanse, 51 mm.

Female (Upper side). Primaries brown, with some golden-yellow overscaling near base and midway to discal band. Discal spots yellowish-brown, similar to those in the male except larger and there is a distinct costal spot above the cell spot and there are three apical spots, lower one is minute and displaced outward from the other two.

Secondaries brown, heavily overscaled with golden-yellow scales over the basal and to near the discal areas. Fringes sordid white and brown at ends of veins.

Female (Under side). Very similar to the male except there is a broad grayish marginal area on both the primaries and secondaries.

Thorax golden-brown above, dark brown beneath. Abdomen brown above, grayish-white striped beneath. Head golden brown. Palpi sordid yellowish-white. Legs and antennae same as in the male.

Wing measurements. Primaries: base to apex, 31.5 mm; apex to outer angle, 20 mm; outer angle to base, 20 mm. Secondaries: base to end of vein 3, 19 mm; center of costa to anal angle, 24 mm. Total expanse, 61 mm.

Type material. Holotype, male, X-Can, Quintana Roo, Mexico, 13 June 1969 (E. C. Welling collector), will be placed in the American Museum of Natural History. Allotype, female, X-Can, Quintana Roo, Mexico, 7 June 1967 (E. C. Welling collector), is in my collection. There is one female paratype, Chichen Itza, Yucatan, Mexico, 1 November 1930 (F. M. Gaige collector), will remain for the present in my collection.

This new species is named for my good friend Lorenzo DeLeon of Ciudad Valles, S. L. P., Mexico, the golf professional at Hotel Cavadonga.

Superficially above this new species slightly resembles *E. windi* Free-

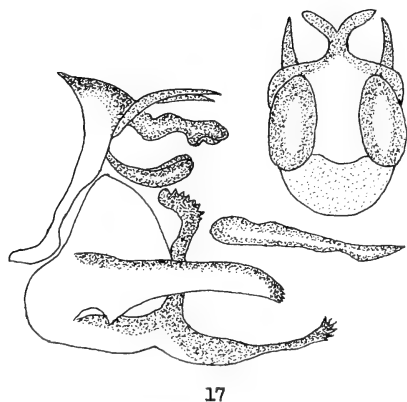
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Figs. 9, 10. *Polythrix guatemalaensis*, n. sp. Allotype, female, X-Can, Quintana Roo, Mexico, 26 July 1962 (E. C. Welling; H. A. F.).

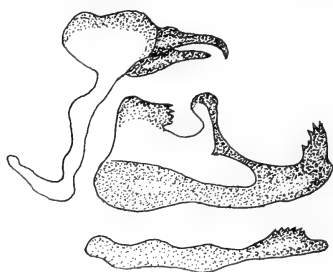
Figs. 11, 12. *Codatractus yucatanus*, n. sp. Holotype, female, Pisté, Yucatan, Mexico, 1 September 1967 (E. C. Welling; A. M. N. H.).

Figs. 13, 14. *Bungalotis milleri*, n. sp. Holotype, male, Candelaria Loxicha, Oaxaca, Mexico, 22 September 1968 (E. C. Welling; A. M. N. H.).

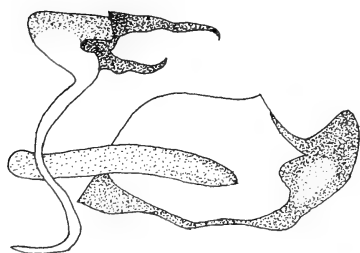
Figs. 15, 16. *Bungalotis milleri*, n. sp. Allotype, female, San Quintin, Chiapas, Mexico, 16 September 1970 (Robert Wind; Allyn Museum).



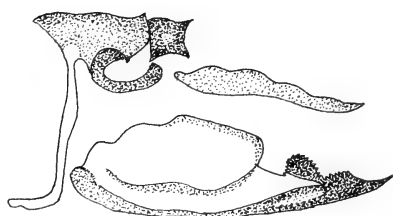
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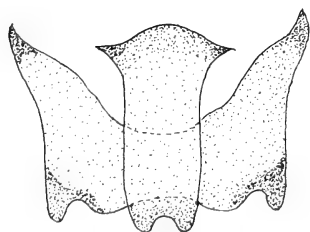
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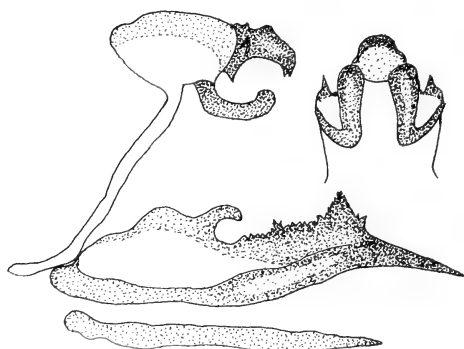
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Fig. 17. Male genitalia. *Pyrrhopyge hoffmanni*, n. sp. Paratype, Tenosique, Tabasco, Mexico, 18 August 1962 (E. C. Welling; H. A. F.).

Fig. 18. Male genitalia. *Epargyreus deleoni*, n. sp. Holotype, X-Can, Quintana Roo, Mexico, 13 June 1969 (E. C. Welling; A. M. N. H.).

Fig. 19. Male genitalia. *Typhedanus salas*, n. sp. Paratype, Piste, Yucatan, Mexico, 29 August 1968 (E. C. Welling; H. A. F.).

Fig. 20. Male genitalia. *Polythrix guatemalaensis*, n. sp. Holotype, Sayaxche, El Petan, Guatemala, 23 August 1963 (E. C. Welling; A. M. N. H.).

man, however, on the lower surface it does not resemble any other species of *Epargyreus* due to the unusual arrangement of the silvery-white discal band.

***Typhedanus salas* Freeman, new species**

Figs. 7, 8, 19

Male (Upper side). Primaries dark brown. There is a dark, straight band of spots between the base and the discal band, extending from space 1b to near the costa. There is a dark discal band which is broken outward at vein 3 and is irregularly continuous with the dark apical band. Fringes dark brown.

Secondaries dark brown, with the slightest indication of a discal band. There is a prominent radiating hair tuft arising from near the base of space 1c, which is yellowish in coloration. The remainder of the wing dark brown. Fringes sordid yellowish-white, unchecked.

Male (Under side). Primaries similar to above except space 1a is yellowish.

Secondaries similar to above except the discal bands are darker.

Thorax dark brown above and beneath. Abdomen dark brown above and beneath. Head dark brown. Palpi light brown. Legs dark brown. Antennae, shaft dark brown, club dark brown with the apiculus orange.

Wing measurements. Primaries: base to apex, 22 mm; apex to outer angle, 15 mm; outer angle to base, 15 mm. Secondaries: base to end of vein 3, 14 mm; center of costa to anal angle, 18 mm. Total expanse, 39 mm.

Female. Very similar to the male, the only difference is on the lower surface of the secondaries near the anal angle where it is a slight degree lighter brown.

Wing measurements. Primaries: base to apex, 26 mm; apex to outer angle, 17 mm; outer angle to base, 19 mm. Secondaries: base to end of vein 3, 18 mm; center of costa to anal angle, 17 mm. Total expanse, 47 mm.

Type material. Holotype, male, Piste, Yucatan, Mexico, 26 August 1968, will be placed in the American Museum of Natural History. Allotype, female, same location, 16 August 1968, is in my collection. There are nine male paratypes and one female paratype from the same area in my collection. All specimens were collected by E. C. Welling.

This new species is named for Felipe Salas, Assistant Manager of Hotel Covadonga, Ciudad Valles, S. L. P., Mexico, who helped me with my collecting in that area of Mexico.

This new species resembles *Typhedanus ampyx* Godman & Salvin except it lacks all of the bright yellow coloration on both surfaces of the secondaries, is somewhat smaller and there are differences in the genitalia. Both species fly together in Yucatan.

***Polythrix guatemalaensis* Freeman, new species**

Figs. 9, 10, 20

Male (Upper side). Primaries dark brown. There is a rather compact discal band of four yellow, hyaline spots. The spot in space 2 is large and square. There

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Fig. 21. Female genitalia. *Codatractus yucatanus*, n. sp. Paratype, Piste, Yucatan, Mexico, 2 August 1967 (E. C. Welling; H. A. F.).

Fig. 22. Male genitalia. *Bungalotis milleri*, n. sp. Paratype, Candelaria Loxicha, Oaxaca, Mexico, 5 August 1969 (E. C. Welling; H. A. F.).

is a small spot in space 1b directly under the outer edge of the spot in space 2. In space 3 there is a small spot directly over the outer edge of the spot in space 2, and the inner edge of the cell spot, and the inner edge of the spot in space 2 form an even straight line. There are three apical spots, one in space 6 is larger than the one in space 8, while the one in space 7 is small. The inner edge of the three spots forms an even curve. The costal fold is well developed. Fringes dark brown, concolorous with rest of wing.

Secondaries dark brown. The lower half of each wing rather badly torn thus not indicating the tail length. Fringes dark brown.

Male (Under side). Similar to above except slightly lighter in coloration and there is a dark area just beneath the apical spots. The veins are slightly lighter than the ground color.

Secondaries brown. There is a dark cell spot and another one just above it. The discal row of spots from 1B to the cell are dark black and very prominent. The veins are slightly lighter than the ground color.

Thorax brown above with some yellowish hair-like scales intermixed, beneath brown. Abdomen brown above and beneath. Head brown with some yellowish hair-like scales intermixed. Palpi yellowish-brown. Legs brown. Antennae, shaft and club, brown above, yellowish beneath.

Wing measurements. Primaries: base to apex, 21 mm; apex to outer angle, 15 mm; outer angle to base, 19 mm. Secondaries: base to end of vein 3, 13 mm; center of costa to anal angle uncertain due to damage of both wings. Total expanse, 41 mm.

Female (Upper side). Primaries very similar to male except there is a distinct costal spot directly over the cell spot. Fringes tan, lighter than the rest of the wing.

Secondaries dark brown. Tails broad and fairly short (5 mm), evenly curved outward. Fringes sordid white, slightly darker at ends of veins.

Female (Under side). Very similar to the male.

Thorax, abdomen, head, palpi, legs, and antennae similar to male.

Wing measurements. Primaries: base to apex, 22 mm; apex to outer angle, 15 mm; outer angle to base, 15 mm. Secondaries: base to end of vein 3, 14 mm; center of costa to anal angle (end of tail), 23 mm. Total expanse, 43 mm.

Type material. Holotype, male, Sayaaxche, El Petan, Guatemala, 23 August 1963, will be placed in the American Museum of Natural History. Allotype, female, X-Can, Quintana Roo, Mexico, 26 July 1962, will remain for the present in my collection. Both specimens were collected by E. C. Welling.

This new species resembles *Polythrix procerus* (Ploetz) on the upper side except in *guatemalaensis* the discal spots are slightly darker and form a more compact band. On the lower surface they do not resemble each other at all due to the very dark cell spot and discal band of *guatemalaensis* on the secondaries. The nearest related species appears to be *P. callias* (Mabille) from Bolivia as there is some similarity in the dark macular bands on the lower surface of the secondaries. The genitalia are distinct.

Codatractus yucatanus Freeman, new species

Figs. 11, 12, 21

Female (Upper side). Primaries uniform dark brown, immaculate except for two indistinct apical spots in spaces 8 and 9. Fringes indistinctly checkered dark and light brown.

Secondaries uniform dark brown, immaculate. Tails approximately 14 mm in length. Fringes indistinctly checkered and light brown.

Female (Under side). Primaries varying shades of brown, somewhat resembling *Codatractus carlos* Evans, except there are no hyaline spots present except two minute apical ones in spaces 8 and 9. The entire coloration is darker than *carlos* and the cellular light area is more extensive.

Secondaries dark brown with heavy black basal and discal markings. The white discal area is similar to that in *C. alcaeus* (Hew.) and not extending as far upward as in *carlos*. There is a dark bar at the upper end of the white discal area. The veins are slightly lighter than the ground color.

Thorax dark brown above, light, yellowish-brown beneath. Abdomen dark brown above, striped yellowish and brown beneath. Head brown, with a white line at the base of the eyes. Palpi sordid yellowish-white. Legs light brown. Antennae, shaft and club dark brown above, beneath shaft minutely striped yellow and brown, club bright yellow.

Wing measurements. Primaries: base to apex, 31 mm; apex to outer angle, 20 mm; outer angle to base, 23 mm. Secondaries: base to end of vein 3, 21 mm; center of costa to anal angle (end of tail), 35 mm. Total expanse, 58 mm.

Type material. Holotype, female, Piste, Yucatan, Mexico, 1 September 1967, will be placed in the American Museum of Natural History. There are eight female paratypes from the same location, collected during June, July, August and September 1967 and 1968, in my collection. All specimens were collected by E. C. Welling.

On the upper surface this species does not resemble any other member of the genus *Codatractus* due to the absence of hyaline spots. On the lower surface it resembles both *carlos* and *alcaeus* based entirely on ground color.

Bungalotis milleri Freeman, new species

Figs. 13, 14, 15, 16, 22

Male (Upper side). Primaries bright orange-fulvous. No hyaline spots. There is a dark brownish-black cell spot. At the end of the cell there is a dark bar and another dark bar midway between the end of the cell and the apical area forming a portion of an evenly curved row of dark apical spots. In spaces 1a and 1b there are two circular dark spots, directly above in space 2 there is a dark marking resembling the letter "B," above this spot is a dark bar midway between the bar at the end of the cell and the one forming the lower portion of the apical spots. There is a distinct costal fold. Fringes dark brown.

Secondaries, costa uniform dark brown with no brilliant blue in side light, remainder of wing bright orange-fulvous. There is a dark cell spot and a row of rather indistinct discal spots. Fringes dark brown.

Male (Upper side). Primaries, costa, apical area and outer margin to midway of space 1 dark brown, remainder of wing bright orange-fulvous. The spots reappear but are much less distinctive.

Secondaries dark brown with some orange-fulvous scales between the dark discal markings which are much more pronounced on this surface of the wing.

Thorax above bright orange-fulvous, brown below. Abdomen above bright orange-fulvous, below approximately the same. Head orange-fulvous. Palpi and cheeks dark tawny with some lighter scales beneath the eyes. Legs light brown. Antennae, shaft both above and below dark brown, club brown, with the terminal end of the apiculus light orange both above and below.

Wing measurements. Primaries: base to apex, 30 mm; apex to outer angle,

20 mm; outer angle to base, 23 mm. Secondaries: base to end of vein 3, 20.5 mm; center of costa to anal angle, 26 mm. Total expanse, 60 mm.

Female (Upper side). Primaries dark brownish-black, with a central band of white, hyaline spots from space 1b to cell, with a detached but approximate spot in space 3. There is a minute, linear spot in space 4 midway between the spot in space 3 and the outer margin, and a minute dot in space 5. There are three apical spots forming a straight line pointing toward the upper fifth of the outer margin. Fringes concolorous with rest of wing.

Secondaries, unmarked, dark brownish-black. Fringes concolorous with rest of wing.

Female (Under side). Very similar to above except space 1b is bright yellowish.

Secondaries dark brownish-black with some gray discal and subbasal spots. There are two spots below the costa that are somewhat lighter in coloration than the others.

Thorax and abdomen dark brown above and below. Head dark brown. Palpi and cheeks dark brown, with the slightest indication of some lighter scales below the eyes. Legs dark brown. Antennae, shaft and club, dark brown, with the apiculus slightly lighter.

Wing measurements. Primaries: base to apex, 40 mm; apex to outer angle, 25 mm; outer angle to base, 34 mm. Secondaries: base to end of vein 3, 30 mm; center of costa to anal angle, 27 mm. Total expanse, 67 mm.

Type material. Holotype, male, *Candelaria Loxicha*, Oaxaca, Mexico, 22 September 1968, will be placed in the American Museum of Natural History. This specimen and two male paratypes from the same location were collected by E. C. Welling. Allotype, female, San Quintin, Chiapas, Mexico, 16 September 1970, collected by Robert Wind, is in the Allyn Museum of Entomology, Sarasota, Florida. The two male paratypes from *Candelaria Loxicha* are in my collection. There is a male paratype in the American Museum of Natural History from Rancho San Carlos, Chiapas, collected August 1968 by Peter Hubbell. There are single male and female paratypes collected 15 November 1971 by Peter Hubbell at Catemaco, Veracruz, Mexico, in the collection of Dr. W. W. McGuire, San Antonio, Texas.

This new species is named for Dr. Lee Miller, Allyn Museum of Entomology, Sarasota, Florida, for his outstanding work on the Rhopalocera.

This new species does not fit any of the known species of *Bungalotis* in that the costa of the secondaries of the males is not shot with blue from the side light thus placing it in the *borax* Evans (1952) complex, but the markings and palpi do not fit other members of that group and the genitalia are distinct even though there are some similarities to *astylos* (Cramer) which has the blue shot on the costa of the secondaries and the cheeks are distinctly white at the base in both sexes.

ACKNOWLEDGMENTS

The author wishes to thank the National Geographic Society for furnishing research grants which made it possible for this research to be conducted during the past four summers. I would also like to thank Dr. Frederick H. Rindge, Curator, Department of Entomology, the American Museum of Natural History, E. C. Welling and Dr. W. W. McGuire for the loan of specimens for determination. The photographs of the adults used in this article were made by Melvin Cannon, ICT Coordinator, Hillcrest High School, Dallas, Texas.

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ABERRANT *ERYNNIS TRITUS TATITUS* (HESPERIIDAE)

Although they occur with some frequency in many genera, aberrant specimens appear uncommon in the North American Pyrginae. Burns, in his monograph *Evolution in Skipper Butterflies of the Genus Erynnis* (Univ. of Calif. Publ. in Entomol., Vol. 37, Berkeley, 1964) made no mention of such in this genus.

In July 1976 while I was collecting in Grant Co., New Mexico, I took an unusual *Erynnis* specimen which I thought at first was a male *horatius* (Scudder & Burgess). Upon genitalic examination, it was determined to be an aberrant *E. tristus tatus* (Edwards), a fairly common species in this region. The specimen was collected along the Gila River at Riverside, 4250' (1295 m), Grant Co., New Mexico on 4 July 76.

Fig. 1 shows the dorsal and ventral views of the aberrant specimen while Fig. 2 illustrates a typical *tatus* taken on the H-Y Ranch, Mule Creek area, Grant Co., N.M., on 10 August 75. In the aberrant specimen, the ventral HW white spots are reduced in size and replaced by pale brown with a central light dot. The wing fringes are brown rather than white. The forewings resemble normal *tatus*. A similar aberrant female was taken S of Silver City, Grant Co., N.M. on 26 August 76.

While I have collected many hundreds of *Erynnis*, including some unusually small and large examples, this is the first aberration that I have encountered.

CLIFFORD D. FERRIS, Bioengineering Program, University of Wyoming, Laramie, Wyoming 82071.



Figs. 1-2. *Erynnis tristus tatus*. 1, aberrant, dorsal left, ventral right; 2, normal, dorsal left, ventral right.

STUDIES ON THE BIOLOGY OF *PARIDES IPHIDAMAS*
(PAPILIONINAE: TROIDINI) IN COSTA RICA

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The tropical butterfly *Parides iphidamas iphidamas* (Fabricius) occurs, along with several congeners (*arcas mylotes* Bates, *arcas mycale* Goodwin & Salvin, *childrenae* Gray, and *erithalion* Druce) in the Premontane Wet and Lowland Tropical Wet Forest life zones (Holdridge, 1967) on the Caribbean drainage of the Cordillera Central in Costa Rica. It is not uncommon to find butterflies of these *Parides* visiting the same patch of *Cephaelis tomentosa* Aubl (Vahl) (Rubiaceae) flowers each day. At higher elevations in Costa Rica, such as the Montane Wet Forest life zone, generally *P. arcas mylotes* prevails, and although *P. erithalion* and *P. childrenae* are relatively rare in premontane wet forest, they are more abundant in Lowland Tropical Wet Forest.

The life cycle and natural history of *P. arcas mylotes* from Costa Rican Premontane Wet Forest have been reported (Young, 1973). The present paper summarized similar information for *P. iphidamas* at the same locality. Being a very widespread and familiar species throughout much of Central America, it is likely that this species has been studied in various places, but data from Costa Rica are not available. Rothschild & Jordan (1906) report that *P. iphidamas iphidamas* ranges from southern Mexico to Panama, and no information is given for the biology of this subspecies and the others. This paper is the second in a series on the biology of *Parides* species in Costa Rica, and it emphasizes differences in early stages and behavior between *P. iphidamas* and *P. arcas mylotes*.

METHODS

Studies were conducted from 10 January through 28 February 1976 on the properties of Compañía Agrícola Myristica S.A. (C.A.M.S.A.) and Compañía Agrícola Hüntro S.A. (C.A.H.S.A.). The two companies have adjacent, extensive land holdings in northeastern Costa Rica. This locality was called "Finca Tirimbina" in Young (1973), and it is ca. 8 km from La Virgen (elev. 220 m), Heredia Province. The region (premontane wet forest) experiences heavy rainfall throughout most of the year and a short, erratic dry period in February and March. Of the land encompassed by both companies (a total of ca. 1500 acres), ca. 60% is still undisturbed primary forest, whereas the remainder is secondary forest and cultivated habitats. Owing, however, to plans to convert most

of the primary and secondary forest habitats into cultivated areas, the habitats of *Parides* are disappearing very fast in this region.

Parides butterflies were studied by searching for adults in a variety of different habitats and recording where they feed and oviposit.

To study the early stages of *P. iphidamas*, several eggs were collected at various times and confined, along with fresh cuttings of the host plant, in clear plastic bags kept tightly shut. The technique is essentially the same used to study *P. arcas mylotus* (Young, 1973). Although *P. iphidamas* has been reared before but incorrectly called *P. arcas mycale* (Young, 1972), the present study focused on the description of the early stages, for comparison with those of *P. arcas mylotus* (Young, 1973). In addition to finding eggs in the wild, two females were confined in separate bags with host plant cuttings to obtain eggs. Both females were caught from the same flower patch and within two weeks of each other during the latter half of January 1976. *Parides* females will generally oviposit readily in captivity, and they can be kept alive on sugar-water solutions for several weeks (Young, 1972). The eggs obtained were reared to the adult stage.

RESULTS

Habitat, Adult Feeding, and Larval Host Plant

Parides iphidamas, in contrast with *P. arcas mylotus* and *P. childrenae*, flies most frequently in open secondary habitats, and along the edges of primary forest. At a flower patch (*Cephaelis tomentosa*) observations of male *Parides* for 3 hr on sunny mornings resulted in the scoring of 8–35 visits of *P. iphidamas* relative to only 3–10 of *P. arcas mylotus* and 1–3 of *P. childrenae*. When *C. tomentosa* is abundantly in bloom in shaded forest, but within a few meters of the forest edge, several species of *Parides* visit the conspicuous red flowers. For example, during the late afternoon of 17 January 1976, six visits by both sexes of *P. iphidamas*, four by *P. arcas mylotus*, and two by *P. childrenae* were scored within 20 min (16:10–16:30 hrs) at a small patch of *C. tomentosa* in an old secondary forest of *Goethalsia meiantha* (Tiliaceae) trees.

Other than *C. tomentosa*, *Parides* has not been seen visiting other inflorescences. However, probably other food sources exist. *Cephaelis tomentosa* produces its large red inflorescences throughout the year, providing a predictable food source for these and other butterflies, in addition to hummingbirds. However, there is considerable asynchrony of flower production within a patch, such that as some flowers wither following several days of bloom, others come into bloom. A far less abundant nectar source for *Parides* at this locality is *Impatiens sultani*

(Balsaminaceae), which occurs as small patches in heavily shaded forest openings where the ground is almost of mud consistency. The pink or red inflorescences attract *Parides* in mountain forest (Young, 1973), where this plant is very abundant. At lowland tropical wet forest localities, the bright red inflorescences of *Hamelia patens* (Rubiaceae) attract *Parides* species (Young, 1971).

At "Tirimbina," *Parides* butterflies share *C. tomentosa* nectaries with some *Heliconius* species (e.g., *H. hecale* and *H. cydno*). In the absence of precise data from field mark-recapture experiments, it appears that males of *P. iphidamas* and other *Parides* are more predictable visitors than females at a given flower patch on a day-to-day basis. For example, at one small forest edge patch of *C. tomentosa*, the same male *P. iphidamas* visited for six successive days, whereas several different females passed through the patch only one time each during the same period. I have witnessed similar patterns at other patches of *C. tomentosa*. On a given day, the same male would reappear 5–30 times at a flower patch, whereas a female would appear only once or twice.

Whereas *P. arcas mylotes* flies along forest edges (Young, 1973), *P. iphidamas* is more abundant in this ecotonal habitat. All 12 oviposition acts took place at forest edges where the larval host plant, *Aristolochia constricta* (Aristolochiaceae), occurs as large mature vines exposed to direct sunlight most of the day. Oviposition takes place throughout the day in clear weather; generally only one egg is laid, but occasionally two or even three eggs are laid separately on a single visit. The egg is always placed on the ventral side of an older leaf on a mature vine. The larval host plant is very abundant along the edges of primary forest, in forest openings, and in open, secondary habitats. Very small seedlings of this species occur in heavily shaded understory of forest remnants, although mature vines are not common in these places. *Aristolochia constricta* is microsympatric with *A. pilosa*, but the latter is generally rare at this locality, and it is not used as a host plant by *Parides* butterflies.

In a previous study, it was estimated that *Parides* females are capable of producing a few hundred eggs (Young, 1972). But the two females held captive in the present study only produced 22 eggs within a few days. One female, a young adult as judged by the condition of the wings, produced eight eggs between 14 and 16 January 1976, and the second female, judged as middle-aged, produced 14 eggs on 5–6 February 1976. Additional eggs could have been obtained, but one female was sacrificed and the other released. All of the eggs appeared viable in terms of size and coloration.

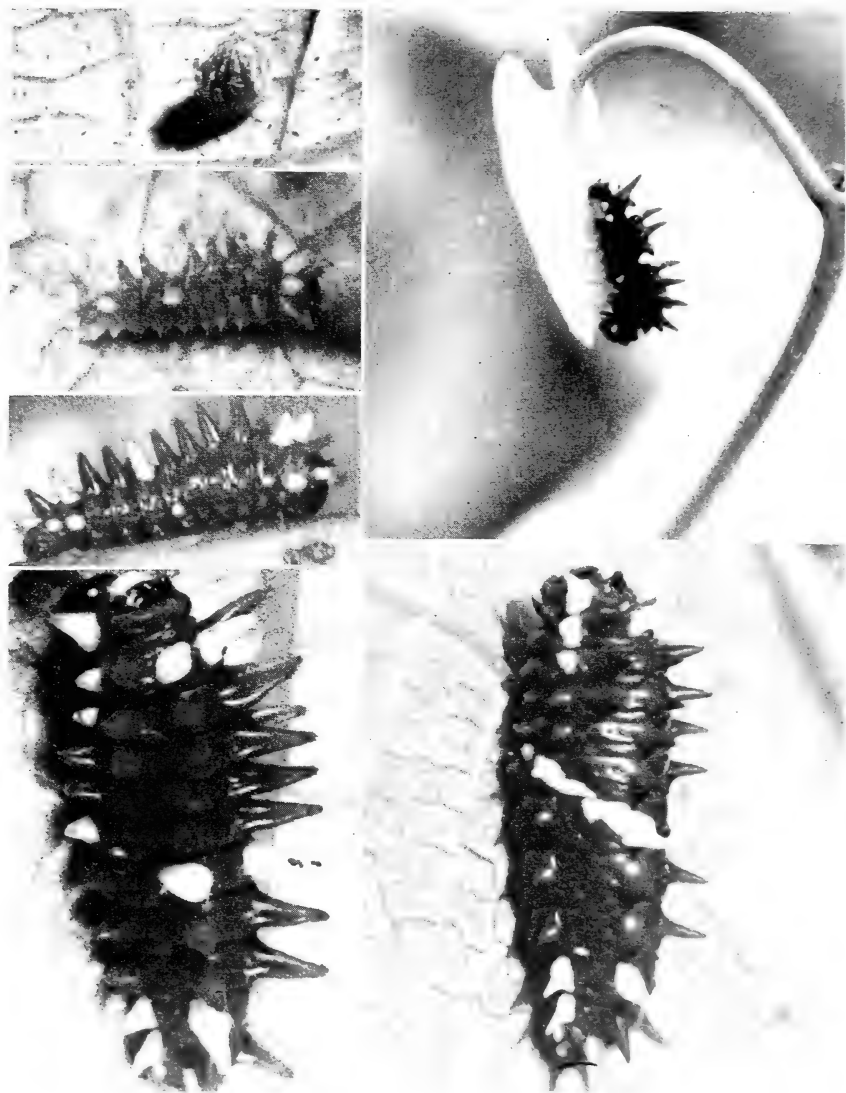


Fig. 1. Early stages of *P. iphidamas*. Left column, top to bottom: egg, first instar, second instar, and third instar caterpillars. Right, top: third instar feeding on *A. constricta* in the wild; right, bottom: fourth instar.

Life Cycle and Behavior of Caterpillars

Egg (Fig. 1). Brown to honey-orange, spherical, clearly visible vertical furrows at 10 \times magnification, 1.0 mm diameter. Hatches in 6–7 days (13 eggs).

First instar (Fig. 1). Thoracic and abdominal areas rusty-orange, head capsule

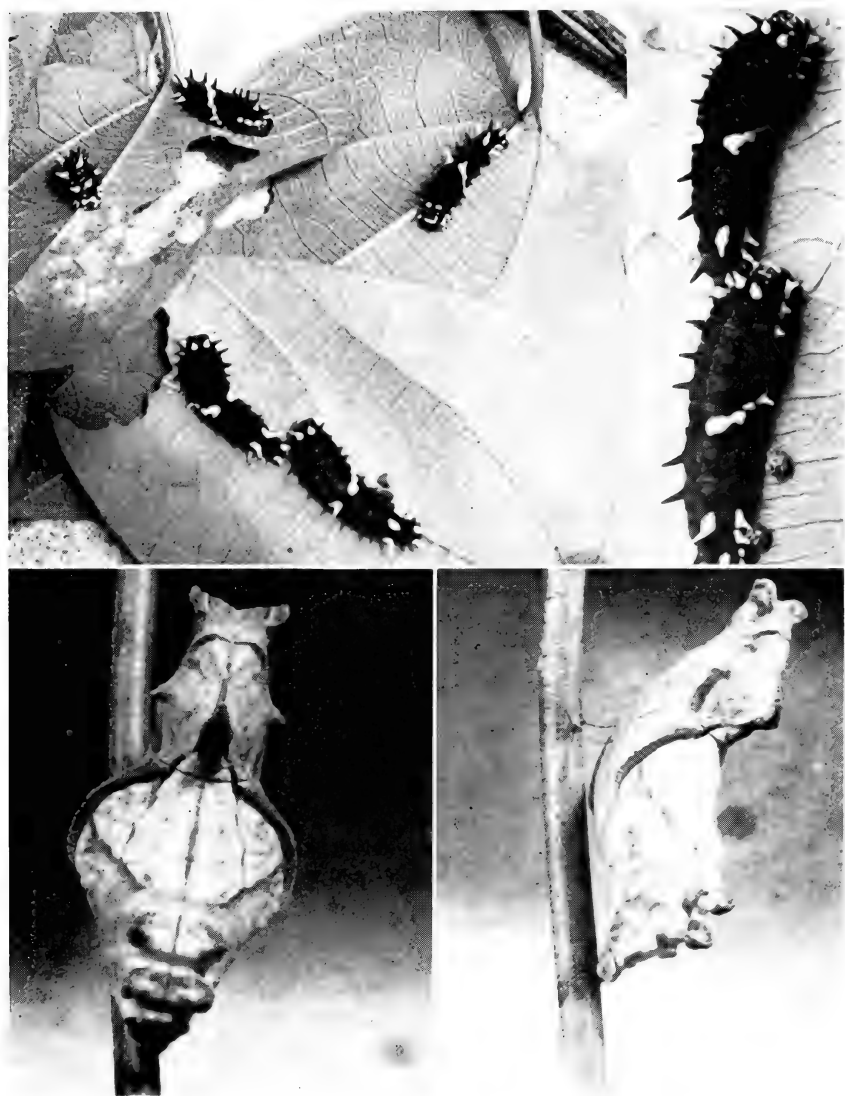


Fig. 2. Top: fifth instar caterpillar. Bottom: frontal and lateral aspects of the pupa.

black. Thoracic and abdominal areas tuberculate. Tubercles white or rusty-orange with latter color replaced by purple in all later instars; otherwise colors and tubercle number and positions the same. Tubercle pattern as follows (all instars): thoracic area bears 3 pairs (dorsal, sub-dorsal, lateral), abdominal area bears 2 pairs (dorsal and lateral). Prothoracic dorsals and sub-dorsals white, laterals rusty-orange; meso- and metathoracic dorsals and laterals white, subdorsals rusty-orange. First abdom-

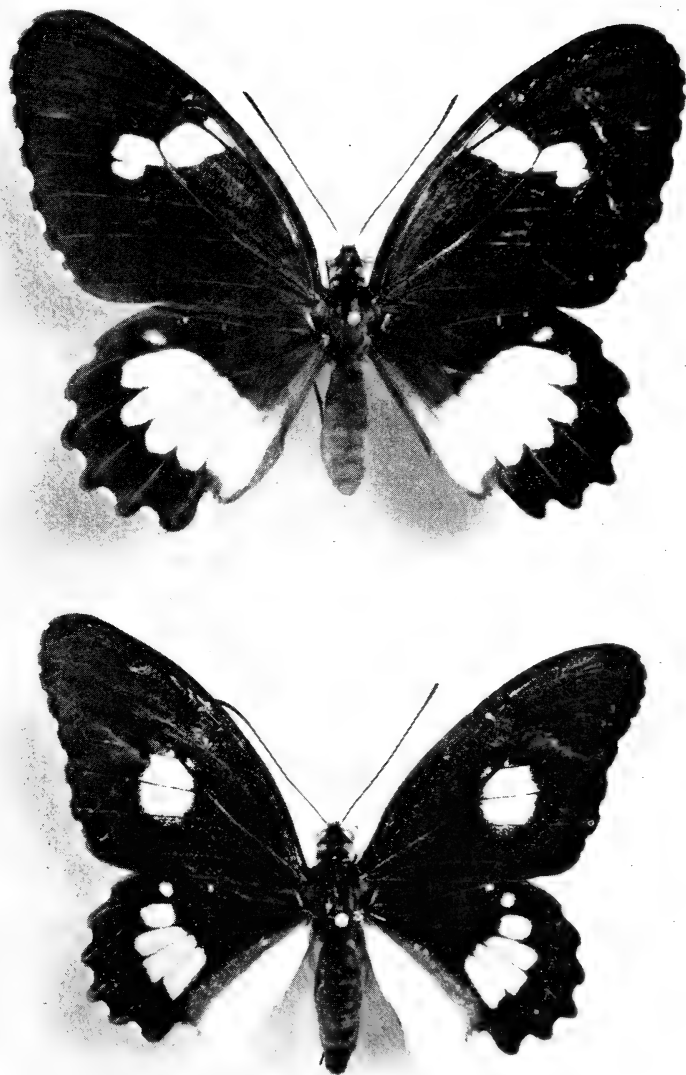


Fig. 3. Adult *P. iphidamas* obtained from laboratory rearing: female above, male below.

inal, both sets rusty-orange, laterals of second abdominal becoming white. Pattern reversed for third abdominal segment. Both sets of fourth and fifth abdominal segments rusty-orange, both white on sixth, only dorsals white on seventh. Both white on eighth and ninth abdominal segments; tubercles of ninth very reduced.

Black setae prominent on tips of all tubercles but disappear in later instars. Grows from 2.5 to 4.0 mm in 5 days; eats egg shell to varying degrees (11 individuals).

Second instar (Fig. 1). As first instar, but with rusty-orange replaced with purple. Prominent white "collar" evident just behind head, present in previous instar but reduced. Body more cylindrical with tubercles shorter relative to thickness of body. Both first and second instars feed on young leaves of host plant in the field and laboratory. Grows from 4.0 to 9.0 mm in 5 days (10 individuals).

Third instar (Fig. 1). Identical in color and form to previous instar. First three instars quickly evert bright yellow osmeteria when disturbed, and this ability diminishes drastically in later instars. First three instars feed from ventral side of young or old leaves in wild. Grows from 9.0 to 23.0 mm in 5 days (8 individuals).

Fourth instar (Fig. 1). Thoracic and abdominal areas cuticle has glossy sheen. One striking color pattern difference retained in fifth instar: white of lateral tubercles of third abdominal segment extends to meet expended white basal area of fourth abdominal segment, giving appearance of thick, broken line connecting the segments. Similar expansion of sub-dorsal tubercle colors on metathoracic area. Grows from 23.0 to 34.0 mm in 5 days (8 individuals).

Fifth instar (Fig. 2). Same as fourth instar. Both fourth and fifth instars eat woody stems of host plant in addition to leaves. Both accept *A. maxima* in the laboratory, but for two tested, both died after feeding several days. Grows from 34.0 to 56.0 mm in 6 days (8 individuals).

Pupa (Fig. 2). Angulate, bluish-green ventrally, yellow-green dorsally; 31.0 mm long, 10.0 mm wide (dorsal-ventral), 15.0 mm thick. Head capsule strongly forked. Darkens to adult colors day prior to eclosion. Lasts 28–31 days (7 individuals). Adult ready for flight 2 hr after eclosion.

Adult (Fig. 3). Good descriptions in Godman & Salvin (1879). Easily distinguished from *P. arcas mylotes* in the wild by marginal dots on wings being white in *P. iphidamas* and red in the former. Females readily identified by presence of variable red spot in cell between veins M_1 and RS ventrally on hindwings; spot always absent in *P. arcas mylotes* examined at this locality.

Total development time 60–63 days (7 individuals).

DISCUSSION

In premontane tropical wet forest regions such as "Tirimbina" and the surrounding area, *P. iphidamas* and *P. arcas mylotes* both exploit *Aristolochia constricta* as a larval host plant. *A. constricta* is by far the most abundant of the four or five species of the genus that occur here. It occurs as large patches in open secondary habitats and as isolated small patches or young single vines in heavily shaded understories of forest remnants that dot the area. Individual vines in forest understory possess thinner leaves than mature vines in open areas, and their leaves are generally darker green. Although four species of *Parides* visit *C. tomentosa* inflorescences in heavily shaded forest understory (old secondary forest) and along forested roads and paths, there is a strong preference for *P. iphidamas* to oviposit on mature vines in open areas, whereas *P. arcas mylotes* oviposits primarily on very small seedlings of *A. constricta* in forest understory. It was noted elsewhere (Young, 1973) that females of *P. arcas mylotes*, presumably mated, make frequent excursions into shaded forest in search of oviposition sites. This is not the case with *P.*

iphidamas. Although females of both species and also those of *P. childrenae*, the latter being a far more elusive species than the other two, may often be found together in the same places, there is a definite preference in *P. iphidamas* for oviposition in open places. In the wild, it is generally easier to follow ovipositing females of *P. iphidamas* than those of *P. arcas mylotes*, and, at least in part, this probably involves a behavioral difference between these species for oviposition site selection. Since *P. arcas* appears to be a species that oviposits in forests, where seedlings and individual vines of the host plant are probably more widely dispersed than in secondary habitats, the females may spend greater amounts of time on a daily basis searching for oviposition sites than do *P. iphidamas* females searching in secondary and forest edge habitats.

Elsewhere (Young, 1973), the developmental time of *P. arcas mylotes* was reported to be ca. 53 days, compared with 60–63 days for *P. iphidamas* in the present study; the host plants were the same in the two studies and rearing conditions very similar. It is expected, however, that an ecological statistic such as developmental time will be very sensitive to subtle environment factors, making comparisons difficult. Certainly the size of adults will be altered by differences in developmental time within and between species. Considerable differences in developmental time occur in *Parides* even when reared under similar conditions (Young, 1972; 1973).

Although caterpillars of *P. iphidamas* and *P. arcas mylotes* are similar in color and size, there are some consistent and useful differences between them that assist in field identification. Since the two species belong to different groups within the genus, differences in early stages are expected. The fourth and fifth instars of *P. arcas mylotes* are colored with a variegated pattern of brownish-purple and velvety black, whereas those of *P. iphidamas* are glossy purple; the caterpillars of *P. arcas mylotes* lack the broken white band of *P. iphidamas* caterpillars. The caterpillar of *P. arcas mylotes* lacks the white coloration of the lateral tubercles of the third abdominal segment that comprises the lower portion of the lateral white band in *P. iphidamas* caterpillars. Furthermore, the caterpillar of *P. arcas mylotes* lacks the white thoracic tubercles of *P. iphidamas* (compare Fig. 3 in Young, 1973 with Fig. 1 in present paper). Other differences occur in the pupa stage for the two species: when placed side by side, it is evident that the pupa of *P. iphidamas* is wider and more greenish-yellow than that of *P. arcas mylotes*, which is narrow and bluish-green.

Aside from the clear differences in the males of *P. iphidamas* and *P.*

arcas mylotes, it is interesting that the males of former species possess a very thick white fold of inner margin on the hindwing. This structure (Fig. 3) is black and reduced in males of *P. arcas mylotes*.

SUMMARY

Various aspects of the biology of the tropical butterfly *Parides iphidamas* were studied at one locality in the premontane tropical wet forest life zone of northeastern Costa Rica. Here, this species occurs with several other of the genus, including the similar-appearing *P. arcas mylotes*. Although both *P. iphidamas* and *P. arcas mylotes* exploit *Aristolochia constricta* (Aristolochiaceae) as a larval host plant, the former species shows a preference to oviposit on mature vines in open secondary habitats and the latter species in forest understory. These species, along with others of the genus, show the same preference to visit *Cephaelis tomentosa* inflorescences in forest understory. Emphasis in interpreting the form and features of early stages is placed on a comparison between *P. iphidamas* and *P. arcas mylotes* caterpillars and pupae for aiding field identifications.

ACKNOWLEDGMENTS

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OBITUARY

RICHARD B. DOMINICK, M.D. (1919–1976)

Dr. Richard B. Dominick, Dick to his friends, died suddenly on 4 May 1976. He appeared healthy in the morning and was dead by the evening; he was spared the difficulty of a lingering illness.

Dick was an energetic, many faceted man. Academically, he was an alumnus of Yale University and the Columbia University Medical School. Among his activities and interests at different times were crew, piloting in WWII and subsequently, boy scout leadership, hunting, fishing, newspaper writing, literature, the Church, medicine, support of the Peabody Museum's research program, the Charleston Museum, photography, the Wedge, Lepidoptera, conservation and preservation of natural areas and people.

I first met Dick in 1968 at the Wedge with Doug Ferguson and Jack Franclemont when the *Moths of America North of Mexico* began to assume form. Since then much of Dick's energy, drive, and talent was directed to making the project a reality. Dick was not a taxonomist, and he readily proclaimed it, but he was determined to play an active role in the series. This he did in several ways: he learned color photography and photographic developing to the point that he produced the excellent positives used for the colored plates; he set deadlines and drove the editor-authors to try to meet them; he made the project financially viable; he provided a setting in which work could be done; and more. The project was left at a stage where it could stand on its merits and momentum and move forward.

Dick was genuinely friendly, helpful, and interested in people. To spend time at the Wedge (the name of his home and property on the Santee River in Charleston County, South Carolina), where many of life's vagaries seemed to vanish, was always a pleasant experience. Dick believed in individuality at a time when many seemed lost in conformity. He usually got up by 3 a.m. and then went to the lab, an extremely well-equipped facility, where he worked on some aspect of Lepidoptera. Meals were taken at varying times. He would literally fall asleep standing up by 8 or 9 p.m. He developed an excellent collection of those butterflies and moths found on the Wedge by bait and light trapping and aerial collecting. He reared many species, particularly saturniids and sphingids and became interested in freeze-drying as a method of preserving larvae and pupae.

I cannot long think of Dick without considering the interplay between him and his wife, Tatiana. She is also a person of immense energy, vitality, and competence, an extremely suitable counterpart to Dick's sometimes boisterous activities. The two were always thoughtful and protective of each other and were jointly responsive to a multitude of demands.

Dick is survived by his wife, his children Julia and Oliver, his stepchildren Elizabeth, Stephanie, Victoria, and Christopher, and a grandson Alexander.

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NOTES ON THE BEHAVIOR OF *ASTEROCAMPA LEILIA*
(NYMPHALIDAE) IN SOUTHERN ARIZONA

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While conducting studies on the Santa Rita Experimental Range, Pima Co., Arizona, in 1970 and 1971, I obtained data on the behavior of *Asterocampa leilia* Edwards, especially with regard to temperature and territoriality. Although these data are largely incomplete, they are reported now because my studies in southern Arizona are not being continued and these aspects of life history are unknown for this species and poorly known for butterflies in general.

METHODS

Relative abundance was determined by counting all butterflies as they were encountered within 5 m of me as I walked through the study area. Time budget studies were made over stopwatch-timed intervals on ca. 10 individuals. Concurrent air shade temperatures (T_a) were obtained. Microhabitats were distinguished as full sun, partial shade with an interspersed sun and shade, and full shade. Posture was expressed as wings fully spread at 180° , wings partially spread, or wings closed tightly together. Orientation with respect to the sun was also noted. Too few data were obtained to ascertain any diurnal changes in behavior patterns that may have been present. Most data on interactions with other fauna were gathered during time budget observations. Data were collected on clear, windless days. Additional miscellaneous life history data were obtained incidentally.

Study Area

The study area was located on the western slope of the Santa Rita Mountains, ca. 10 km SE of Sahuarita, at an elevation of 1150 m. The area was relatively flat, sloped slightly to the northwest, and was dissected by a maze of small and large desert washes. The community, including the study area, was described as desert-grassland (Lowe, 1964) which has been invaded by considerable woody growth mainly as a result of protection from fire (Humphrey, 1958). No grazing has occurred in much of the area for the last several years. The dominant vegetation included mesquite (*Prosopis glandulosa*), paloverde (*Cercidium microphyllum*), hackberry (*Celtis pallida*), and cholla cacti

(*Opuntia fulgida* and *O. spinesior*), with an understory of several grass species, some small woody bushes, succulents, and herbs. Photographs of the area were published by Anderson & Anderson (1973).

Rainfall and temperature were typical for this part of Arizona. Rain fell principally in winter (December–February) and summer (July–August). Daytime temperatures during midsummer commonly exceeded 35°C whereas morning lows were often near 20°C.

Territoriality

Males of *A. leilia* flew at and chased nearly anything that came close to them. I have records of 179 attacks by males, of which 64 were intra-specific, 78 were directed at other butterfly species that ranged in size from *Microtia dymas* Edwards to *Battus philenor* (L.), one was directed at the moth *Celerio lineata* (Fabricius), 24 at Odonata, 11 at Hymenoptera, including one at an ant, and one at a lizard (*Cnemidophorus* sp.). I never saw one fly directly at a bird, although perched *A. leilia* usually flew when a bird passed overhead.

No butterflies were marked, but three males I studied were recognizable by distinctive tears in their wings. These three were apparently resident for at least 8, 14, and 17 days after I first saw them. Additionally, males which were observed at various times throughout the course of a day remained within a definite area at all times. These used very few perch sites, of which one or two seemed preferred and were returned to time after time following flights. Favored perch sites were on the ground, in a wash, and usually near the center of the area used by the individual.

The majority (63%) of flights were initiated by disturbance caused by another organism passing over or near a perched individual. Many of these flights terminated in a patrol within a well-defined area that did not change diurnally or over several days. Furthermore, many flights were initiated without any obvious stimulus when the butterfly would similarly patrol this area. The patrolled areas of neighboring individuals overlapped little. Many intraspecific interactions occurred near the boundaries of the patrolled areas when one male entered the area occupied by another. Invariably, the intruding individual was chased by the resident male. Nearly all of these areas were along washes.

This strong site tenacity and associated behavior indicate true territoriality. The occurrence of territoriality in butterflies has been the subject of some debate. Considerable evidence for territoriality in males of two Nymphalids was presented by Baker (1972). Scott (1974), however, argued that territoriality was absent or rare among butterflies.

TABLE 1. Average length of intraspecific and interspecific interactions by *Asterocampa leilia* males.

Interaction with	Mean number of seconds		Total
	T _a < 30°C	T _a > 30°C	
<i>Asterocampa leilia</i>	18.0 ¹ (9) ²	15.6 (14)	16.8 (23)
Other butterflies	6.5 (26)	5.1 (21)	5.9 (47)
Other insects	—	—	5.9 (26)

¹ Seconds.² Number of flights.

He claimed that site tenacity was poor and that the apparent pugnacity of perched males was in reality a mate-seeking behavior.

My data on *A. leilia* indicate that although males were disturbed by nearly any passing object, a distinct difference existed between responses to and contacts with intraspecific and interspecific objects. Intraspecific interactions averaged nearly three times longer than interspecific interactions (Table 1). Thus, males were able to quickly distinguish a conspecific. Initially, all contacts were investigative. If the individual was not an *A. leilia*, it was on occasion chased briefly, but usually not out of the defined area. Conspecific males were pursued to the boundaries of the area. Four contacts with known female *A. leilia* lasted an average of 35 s. The results of these contacts were unknown, but after one, the male could not be found within his known territory, although he was present later in the day. The pair may have disappeared into the vegetation. On one occasion, I found a male and female perched near each other in the middle of a *Celtis pallida*.

Fourteen territories were examined in some detail. All except one were along washes. They contained an average of 5.7 (range 4–10) shrubs and small trees of which an average of 1.6 (range 1–3) were *C. pallida*. This tree was the only one common to all territories. The defended area averaged 0.07 ha. (range 0.03–0.13 ha).

The territorial behavior of *A. leilia* shows both similarities and differences to that of two other Nymphalids (Baker, 1972). *A. leilia* is similar to *Aglais urticae* (L.) in that the male defended an area which included an oviposition site, whereas *Inachis io* (L.) males defended areas along female flight paths on route to oviposition sites. *Asterocampa leilia*, however, was similar to *Inachis io* in that there was but one male per territory. In *Aglais urticae*, territories were often occupied by several males. *Asterocampa leilia* apparently defended territories for much of the day compared with only ca. 4 h per day by *Inachis io* and 1.5 h per day by *Aglais urticae*. The latter two species

TABLE 2. Time budget and number and length of flights for male *Asterocampa leilia* as a function of ambient temperature.

	Ambient Temperature (°C)			
	20-25	25-30	30-35	35-40
% time perched	92.6	91.8	81.0	98.6
% time flying	7.4	8.2	19.0	1.4
Total time (s)	2181	15426	10812	3636
Mean number of flights per hour	3.2	25.2	39.0	2.2
Mean length of flights (s)	81.0	11.1	17.6	25.5

spent much of the morning feeding; I have observed feeding by adult *Asterocampa leilia* but once (on Coyote, *Canis latrans*, feces containing much *Opuntia* fruit).

Temperature-related Behavior

Behavior of *Asterocampa* was greatly affected by temperature. Amount of time spent flying was ca. 8% at low T_a , increased to 19% at moderate T_a and decreased to less than 2% at high T_a (Table 2). At a T_a of 20-25°C, few flights were made (Table 2), but these were long in duration and usually very fast and erratic. These were usually the first flights of the day. Later and at warmer T_a , flights were more frequent and of shorter duration. These were usually the slower stroke-glide type of flight characteristic of the species. At high T_a , flights were again infrequent and of relatively short duration (Table 2). Pursuits also apparently decreased in length with increasing T_a as shown in Table 1, although the sample size is small.

As temperatures increased, there was a gradual shift in use of perch sites from those completely exposed to the sun at low T_a to those completely shaded at high T_a (Table 3). The positioning of the wings also varied overall and within the three microhabitats used for perching, with T_a . At low T_a , the wings were nearly always spread when the butterflies were perched; above 30°C, the wings were nearly always

TABLE 3. Microhabitat usage by male *Asterocampa leilia* as a function of ambient temperature.

Microhabitat	Usage (% Total Time)			
	20-25°C	25-30°C	30-35°C	35-40°C
Sun	100.0	74.1	25.7	0.0
Partial shade	0.0	24.2	32.7	0.0
Shade	0.0	1.5	41.5	100.0

TABLE 4. Wing position by male *Asterocampa leilia* as a function of ambient temperature.

Position	% Total Time			
	20-25°C	25-30°C	30-35°C	35-40°C
Spread	99.2	51.6	3.9	0.0
Partially spread	0.0	25.3	4.6	0.0
Folded	0.8	23.1	91.5	100.0

folded dorsally (Table 4). At moderate T_a , the wings were spread more when perched in full shade than when perched in partial shade or in full sun (Table 5).

At each T_a , even when perched in the shade, the males nearly always perched with the head facing away from the sun. This was usually the orientation at which they alighted following a flight. If not, they so aligned themselves almost immediately.

There are few other quantitative data that illustrate the various aspects of behavioral thermoregulation by butterflies as outlined by Clench (1966). *Asterocampa leilia* reacted behaviorally to temperature in a manner similar to that described for the nymphalids *Argynnis paphia* (L.) by Vielmetter (1958) and *Precis villida* (Fabricius) by Heinrich (1972).

Asterocampa leilia is a dorsal basker as is typical for nymphalids in general (Clench, 1966). This species showed all the characteristic behavioral patterns of dorsal baskers. At cool T_a , the wings were opened fully so that they were maximally exposed to the sun. With increasing T_a , the degree of opening was varied to adjust the amount of heat gain. This was concurrently augmented by selection of an appropriate microhabitat to further control the rate of heat gain. Still additional control was attained by slowly opening and closing the wings while perched. This behavior was noted 0.8% and 2.2% of the total perching time at a T_a of 25-30°C and 30-35°C, respectively, but not at any other T_a . Heat loss or reduction of solar heat gain at high T_a was facilitated by selecting the coolest microhabitat and reducing activity to a minimum.

TABLE 5. Percent of time wings are folded by male *Asterocampa leilia* in three microhabitats as a function of ambient temperature.

Microhabitat	% Time Folded			
	20-25°C	25-30°C	30-35°C	35-40°C
Sun	0.8	22.3	100.0	—
Partial shade	—	27.0	91.8	—
Shade	—	0.0	87.1	100.0

TABLE 6. Percent of *Asterocampa leilia* in counts of butterflies on the Santa Rita Experimental Range.

Year	<i>Asterocampa leilia</i> (%)						
	May	June	July	Aug.	Sept.	Oct.	Nov.
1970	8.9	15.2	26.3	25.2	23.2	0.0	—
1971	7.7	5.0	51.6	29.1	41.1	—	38.1

Normal activity in *A. leilia* occurred in the T_a range of 25–35°C, slightly higher than the generalized range given by Clench (1966) and that for an alpine species (*Erebia epipsodea* Butler) by Brussard & Ehrlich (1970). *Asterocampa leilia* was actually active in a temperature niche considerably warmer than this for much of the day, since the temperatures given herein were obtained in the shade. Exposed air temperature taken with a silver-bulbed mercury thermometer average ca. 5°C greater than shade T_a . The radiational heat load on a relatively dark-colored insect would be even greater. Considerable interspecific differences have been shown in the active thoracic temperatures of butterflies (Heinrich, 1972). *A. leilia* apparently flies with and is able to tolerate high thoracic temperatures, which is of definite adaptive value in the southwestern deserts.

General Life History

On the Santa Rita Experimental Range, adult *A. leilia* were active from early May–mid-November. Fresh individuals were noted throughout the flight period. Peak abundance (both actual and relative) was from early July–September (Table 6). The daily flight period was long. The first flying individuals undisturbed by me were observed as early as 30 min. after sunrise but more usually 90 min. after sunrise. These early morning flights, as noted above, were usually very fast and erratic. The last active individuals were noted just before sunset.

The general behavior of males was described in detail above. Females were observed infrequently. They appeared to fly along washes until intercepted by a male. Females were usually encountered by examining *Celtis pallida* bushes, where they were found perched in the shade on the lower sides of branches. In most cases, they remained in this position for considerable periods, up to at least 2 h.

Oviposition was noted four times, all on *C. pallida* and between 0930 and 1200. Eggs were laid in clusters of 10, 11, 13, and 15. Three clusters were on the upper side of leaves, and one was on the lower side. In each case, hatching took place on the seventh day following oviposition.

Thirty-six of the 49 eggs hatched; the remaining eggs showed no signs of development. On one occasion, I found a female perched in a *C. pallida*. She perched for 82 s, flew slowly with a male among the branches of the *C. pallida* for 16 s, then laid a cluster of 10 pale yellow eggs on the lower side of a leaf in 109 s. After this, she again perched for 455 s before flying out of sight.

The behavior of males perching with the head facing away from the sun, as noted earlier, may also function in quickly detecting the approach of an object from behind. Such an object would cast a shadow which passes by the perched individual before the object itself. Many times I noted males initiating flight in response to a shadow before the object itself was in view.

I never observed *A. leilia* visiting flowers or mud puddles. Other *Asterocampa* were reported to visit mud puddles (Klots, 1951).

SUMMARY

Territorial and temperature-related behavior of *A. leilia* were investigated in southern Arizona. Males appeared to be truly territorial. They investigated nearly all passing objects and chased conspecific males to the boundary of a well-defined area. These territories were described. Behavior by males was temperature dependent, with a shift from exposed to shaded microhabitats as temperature increased. Concurrent changes in other behavior patterns also occurred. Other miscellaneous life history notes were presented.

ACKNOWLEDGMENTS

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UNIFORM GENITALIA AMONG WING COLOR MORPHS OF OLETHREUTID MOTHS

Most traits are said to be uniform among lepidopteran wing color morphs (Ford 1975, Ecological Genetics, ed. 4, 442 p., John Wiley & Sons, New York). This uniformity presumably includes structure, specifically genitalia. Important as they usually are taxonomically, genitalia are seldom mentioned in literature on wing color polymorphism (Robinson 1971, Lepidoptera Genetics, 687 p., Pergamon Press, New York). Because wing color polymorphism in well studied examples is controlled by only one or a few genes, structural uniformity is expected and hence not likely to be reported.

In olethreutids, wing color polymorphism and its genetics have been little studied. The occurrence of wing color morphs is problematic in many little known species in this family. Empirical evidence for genitalic uniformity among putative wing color morphs could be taxonomically helpful. From Opler's (1971, J. Lepidop. Soc. 25: 115-123) discussion of two species of *Epinotia* having wing color morphs, uniform genitalia can be inferred. I report here explicitly on this point in two additional species.

Sciaphila duplex (Walsingham) (subfamily Olethreutinae), feeding on *Populus tremuloides* (McGregor 1967, J. Econ. Ent. 60: 1213-1216), has two wing color morphs (Heinrich 1926, U.S. Nat. Mus. Bull. 132, 216 p.), one of which is melanic in both sexes. The melanic morph numbered 5 of 54 specimens from Michigan, Ontario, and Minnesota. Genitalia comparison between the morphs was based on 2 or more genitalia slide preparations of each sex (9 preparations in all).

Epinotia solandriana (Linnaeus) (subfamily Eucosminae), feeding chiefly on *Betula*, has 4 main wing color morphs (Lindquist and MacLeod 1967, Can. Ent. 99: 1110-1114), each in both sexes. These morphs may not be sharply discontinuous. Using specimens from Ontario, Wisconsin, and Michigan, I compared genitalia among these 4 morphs with 1-7 preparations of each sex (18 preparations in all). Comparisons were made under a light microscope at 60-90 \times , magnifications normally used in genitalia study. There were no genitalic differences between color morphs in either sex of either species. This result confirms expectation and strengthens the usefulness of genitalia for ascertaining presence or absence of wing color polymorphism in olethreutids.

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CUDONIGERA: A NEW GENUS FOR MOTHS FORMERLY
ASSIGNED TO *CHORISTONEURA*
HOUSTONANA (TORTRICIDAE)

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During 1952–1966 Dr. N. S. Obraztsov worked as a Research Fellow at the American Museum of Natural History, New York, on a generic classification of Nearctic Tortricinae. In the process he progressively expanded the scope of his work, both geographically, into the Neotropical fauna, and in the taxonomic level of treatment, which led him to several detailed reviews at the species level. Unfortunately, these studies diluted his concentration on the generic revision, and at the time of his sudden death in 1966, only parts of the comprehensive study had been completed. A summary of Obraztsov's life and varied work on Lepidoptera has been given by Diakonoff (1966).

The generic treatment, which is intended to accompany and augment that of Obraztsov (1954–1957) treating the Palearctic fauna, is being continued by Powell. This has involved incorporation of considerable Mexican Nearctic material accumulated during the past decade, enabling clarification of relationships among North American genera. Particularly in the Cnephasiini, the New World fauna appears to consist of Neotropical elements, with the depauperate Nearctic representation showing little relationship to the Palearctic, and this tribe was developed only preliminarily in Obraztsov's manuscripts. By contrast, the Tortricini and Archipini consist primarily of Holarctic or Nearctic genera which appear to be more clear-cut, and Obraztsov had completed study of most of them.

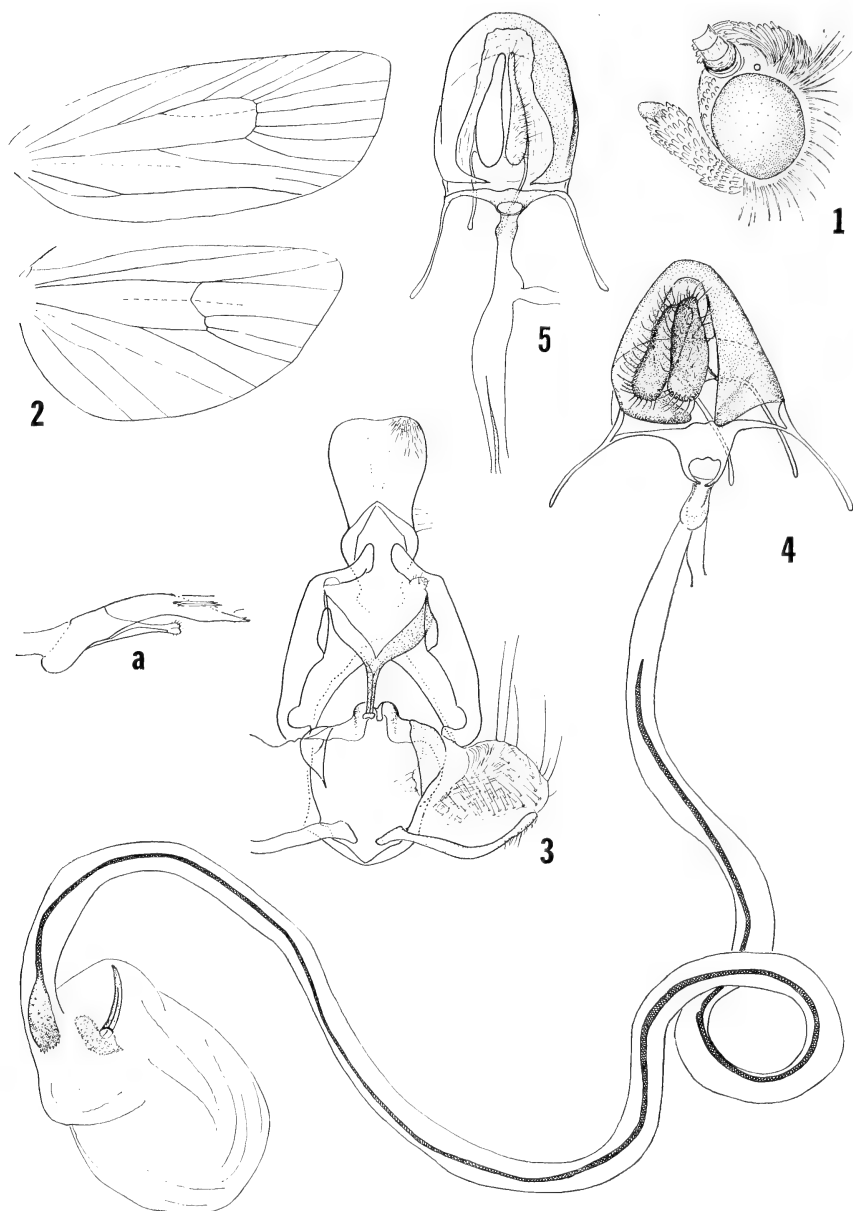
The genus *Cudonigera* was envisioned by Obraztsov as monobasic, related to the Holarctic genus *Choristoneura* Lederer. Current research by Mutuura and Munroe at Ottawa indicates that the populations referred to *C. houstonana* (Grote) should be considered a complex of allopatric species. The genus is proposed to make the name available for use in their studies.

***Cudonigera* Obraztsov and Powell, new genus**

Type species: *Tortrix houstonana* Grote, 1873.

Tortrix (in part); Grote, 1873, Bull. Buffalo Soc. Nat. Sci. 1: 15. Fernald, 1882,

¹ Deceased in 1966. This study was in part conducted through support from National Science Foundation grants to Obraztsov, in 1959–1965.



Figs. 1-5, *Cudonigera houstonana* (Grote): 1, head, lateral aspect; 2, wing venation; 3, male genitalia, ventral aspect, aedeagus removed, *a* aedeagus lateral aspect; 4, 5, female genitalia with structures of VIII-X segments in venterolateral aspect in 4, ventral aspect in 5, showing lateral rotation of papillae anales.

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- Lozotaenia* (in part); Walsingham, 1879, Illustr. typical specimens of Lepid. Heterocera 4: 13.
- Cacoecia* (in part); Meyrick, 1912, in Wagner, Lepid. Catalogus 10: 21; 1913, in Wytzman, Genera Insectorum, fasc. 149: 25. Barnes & McDunnough, 1917, Check list Lepid. Boreal Amer.: 177.
- Archips* (in part); McDunnough, 1939, Mem. Southern Calif. Acad. Sci. 2(1): 56.
- Choristoneura* (in part); Freeman, 1958, Can. Ent. 90, suppl. 7: 38. Powell, 1964, U. Calif. Publ. Ent. 32: 185.

Adult: Head (Fig. 1) densely appressed scaled, face smoother. Antennae in male shortly ciliated and with setae; in female only with setae. Labial palpi ascending, densely appressed scaled; second segment length about 0.8 eye diameter, slightly dilated apicad; third segment about 0.3 as long as second, blunt, exposed.

Forewing (Fig. 2) elongate-rectangular, moderately broad; costa gently arched; apex obtuse; termen rather straight, sometimes slightly convex, tornus broadly rotundate; dorsum gently convex, more curved basad. No costal fold in male. Twelve veins, all separate; Sc slightly curved, almost straight; R_1 from just before middle of discal cell; R_2 twice as near to R_3 as to R_1 ; R_3 and R_4 slightly diverging costad; R_4 to costa, R_5 to termen; upper internal vein rudimentary, from between R_1 and R_2 ; M_2 nearer to M_3 than M_2 to Cu_1 ; Cu_1 from lower angle of discal cell; Cu_2 from shortly before two-thirds; A_1 vestigial, distinct tornad; basal fork of A_{2+3} slightly longer than one-third of entire vein.

Hindwing (Fig. 2) rotundate-subtrapezoidal; costa slightly sinuate, convex at middle; apex rotundate; termen flat or slightly concave below apex; tornus and dorsum forming a strongly convex arch. Eight veins; S almost straight; R and M_1 connate or short stalked; M_2 gently bent downward basad, remote from M_3 ; M_3 close to Cu_1 , separate; Cu_1 from lower angle of discal cell; Cu_2 from two-thirds. No cubital pecten.

Male genitalia (Fig. 3): Mensis ventralis represented by two narrow, sclerotized folds of intersegmental membrane. Tegumen strong, wide, with broad, flat shoulders; pedunculi broad, narrowed basad, and bent inward at extreme base; saccus rotundate. Gnathos strong, with a long, narrow middle process. Socii minute, rudimentary. Valvae weak, short, rotundate; costa not sclerotized; sacculus moderately broad, slightly longer than lower edge of valva, with a free tip; valvula finely striated; pulvinus soft, interior; no processus basales. Uncus broad, spatulate, dilated apicad, concave at caudal margin. Fultura superior a slightly arched, transverse bar between upper internal angles of valvae, with a short, blunt projection at middle. Fultura inferior subcordate, haired laterad at upper margin; caulis short, joined to aedeagus slightly before its middle. Aedeagus slightly curved; cornuti few, rather short and thick, deciduous.

Female genitalia (Figs. 4, 5): Papillae anales rotated 90° outward, forming a blade-like ovipositor, hidden below eighth abdominal tergite which is enlarged, strongly sclerotized, forming a helmet-shaped cover that extends caudad beyond genitalic opening. Sinus vaginalis wide; sterigma represented by lamella post-vaginalis only, broad in middle, narrowed laterad. Antrum elongate, slightly sclerotized, rotundate cephalad, with two lateral colliculi caudad. Ductus bursae coincident with antrum. Bursa copulatrix with corpus ovate and cervix bursae long; cestum narrow, longitudinal, band-like, dilated at corpus bursae, not reaching antrum. Ductus seminalis opening into antrum. Signum a strong, curved thorn; its basal sclerotization formed as a serrate, scobinate plate; no capitulum.

Final instar larva: Sharing Archipini characters as defined by MacKay (1962: 29). Head: adfrontal sutures sinuate and adfrontals not attenuated posteriorly. Thorax: meso- and metathorax with SV group bearing one seta; dorsal pinacula not elongated posteriorly; SD_2 dorsal to SD_1 rather than anterodorsal. Abdomen:

D₂ pinacula on anterior segments with mesal margin below lateral margin of D₁ pinacula; SV groups on segments 1, 2, 7, 8, 9 with 3, 3, 2, 2, 2 setae; D₁'s on anal shield distinctly closer to corresponding SD₁'s than to each other; crotchets variably biordinal, 34–44 on abdominal, 28–36 on anal proleg; anal fork well developed, 3–8 times. (Based on examination of larvae from California and the description given by Heinrichs (1971) of Kansas specimens.)

Remarks: This genus evidently is a New World derivative of *Choristoneura* Lederer, from which it differs in having a smoother scaled head, the antennae not serrated in male, shorter, broader labial palpi, and a slightly longer basal fork of the forewing vein A₂₊₃. The male genitalia of *Cudonigera* have a broader tegumen with large shoulders; the uncus is shorter and broader than in all known *Choristoneura* species. The gnathos is differently shaped; its lateral arms are shorter and broader, with the middle process narrower and longer. The valvae are shorter than in *Choristoneura*. The female genitalia are unique, with a hypertrophic development of the eighth abdominal tergite which forms a kind of helmet-shaped cover over coriaceous papillae anales (*cudo*, a helmet made of skin; *-gera*, bearing).

The distinctive features, particularly the rudimentary socii, elongate-narrow joined portion of the gnathos, and blade-like ovipositor situated beneath the hood-like development of the tergite, are characters shared by no species of *Choristoneura*. The short valvae and the larval characters suggest a relationship with Group 1 of MacKay (1962: 36), including *C. conflictana* (Wlk.) and *C. fractivittana* (Clem.), rather than with the conifer-feeding *Choristoneura* (*fumiferana* and related species).

Cudonigera houstonana (Grote), new combination

Tortrix houstonana Grote, 1873, Bull. Buffalo Soc. Nat. Sci.: 15. Fernald, 1882, Trans. Amer. Ent. Soc. 10: 17. Grote, 1882, New check list of North Amer. moths: 58. Fernald, "1902"/1903/, Bull. U.S. Natl. Mus. 52: 482.

Cacoecia houstonana; Meyrick, 1912, in Wagner, Lepid. Catalogus 10: 21; 1913, in Wytman, Genera Insectorum, fasc. 149: 25. Barnes & McDunnough, 1917, Check list Lepid. Boreal Amer.: 177.

Archips houstonana; McDunnough, 1939, Mem. Southern Calif. Acad. Sci. 2: 56.

Choristoneura houstonana; Freeman, 1958, Can. Ent., 90, suppl. 7: 38. Powell, 1964, U. Calif. Publ. Ent. 32: 185 (biol.). Heinrichs & Thompson, 1968, Can. Ent. 100: 750 (biol.).

Lozotaenia retana Walsingham, 1879, Illustr. typical specimens Lepid. Heterocera 4: 13.

Tortrix retana; Grote, 1881, Papilio 1: 9 (synonymy).

Types: of *houstonana*, Texas; location of type specimen unknown; of *retana*, male, Bosque County, Texas, October 5, 1874 (Belfrage), in British Museum (Natural History).

Taxonomic discussion: Aspects of the geographical variation have been discussed elsewhere (Powell, 1964: 186). Populations referred to

the name *houstonana* occur in Massachusetts, Kansas and are widely scattered in the western United States, associated with the island-like distribution of the larval foodplant, *Juniperus*. As noted, considerable diversity in size, forewing pattern and hindwing color exists, in part represented by samples in collections that are too fragmentary to permit adequate assessment. Presumably the color variation is related to cryptic resemblance of the resting moths on their coniferous hosts, but degrees of reproductive isolation may have been attained among some populations. Morphological differences were not observed during our investigations (genitalia preparations examined; 9 ♂, Calif., Colo., Texas, Mass.; 4 ♀, Calif., Texas).

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THE STATUS OF THE GLYPHIPTERIGIDAE AND A REASSESSMENT OF RELATIONSHIPS IN YPONOMEUTOID FAMILIES AND DITRYSIAN SUPERFAMILIES¹

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Current studies of the North American Glyphipterigidae have revealed major fundamental morphological and behavioral characters which demonstrate that the inclusion of the choreutid and glyphipterigid groups within a single family is untenable. The discordant characters involved have been shown in the past by other workers to be so fundamentally and evolutionarily conservative in Lepidoptera phylogeny that it is not even possible to consider the two groups to have evolved within the same superfamily.

Glyphipterigid moths have long been considered of unusual interest because of apparent affinities to the Yponomeutidae and the Sesiidae, as well as to the Tortricidae. Most early workers considered them as distinct groups: the choreutids were placed with the tortricids and the glyphipterigids *sensu stricto* were placed among the tineoid moths. This segregation was rarely altered until Meyrick (1914) combined them into one family. Meyrick's classification was based largely on general facies—the two groups share a number of superficial characters—and not fundamental relationships. He also relied strongly on wing venation and did not use genitalia, internal morphology or larval characters. He formed a conglomeration of what now are no less than nine distinct families in several superfamilies, although he realized the true affinities of many of the included genera in later years. Current revisionary studies on the choreutids and glyphipterigids, using modern systematic techniques, are revealing the true affinities of these moths. The results of these studies to date have confirmed the polyphyletic nature of the Glyphipterigidae *sensu lato*, first indicated by Brock (1967).

Glyphipterigid Discordancies

Brock (1971) revealed certain previously unused characters of ditrysin internal morphology of which the sternal abdomino-thoracic articulation provides a significant character for Lepidoptera phylogeny and

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the affinities of families. Whereas most genitalic characters are evolutionarily plastic at the species level in most groups, due to the selective pressures for reproductive isolation, it is clear that characters not likely to be involved in active selection should remain relatively stable and, consequently, useful in assessing the relationships of higher categories. The abdominal articulation in Lepidoptera appears to be such a stable character.³

Two types of sternal articulation are found in adult Ditrysia: the Tineoidea type, having elongated sternal rods internally in the second sternal sclerite and with apodemal projections into the thoracic lumen, and the Tortricoidea type, having simple apodemes. There are minor variations in these types, but only the two major conformations of abdominal articulation are found in Lepidoptera. Having examined 16 genera of choreutids and 9 genera of glyphipterigids, including all 50+ Nearctic species assignable to these two groups, and many species of Paenarctic and Palearctic origins, I have found no discrepancy in the abdominal articulation of any in terms of assignment to either group. All the choreutids have tortricoid apodemes, and all the glyphipterigids have tineoid rods. This articulation discordancy, consequently, indicates that the two groups have not evolved from a recent common ancestor.

Another lepidopteran character considered evolutionarily conservative at the family level is the chaetotaxy of larvae, with particular interest here involving the lateral pre-spiracular setal group of the larval prothorax (Werner, 1958; MacKay, 1963; Peterson, 1965; Common, 1975). The glyphipterigid *sensu stricto* larvae have a bisetose pre-spiracular setal group on the prothorax. The choreutids have a trisetose pre-spiracular setal group. The polyphyly of the Glyphipterigidae *sensu lato* is here again demonstrated by a character used in the Lepidoptera.

A third fundamental character useful in the higher classification of Lepidoptera is pupal behavior at adult ecdysis and again the two groups show no recent common ancestry. The glyphipterigids do not protrude the pupa at adult ecdysis, and the choreutids do protrude the pupa. The protrusion or non-protrusion behavior is characteristic of superfamilies in the Ditrysia. It should be noted that this behavior involves the presence or absence of genetic components that form the pupal exterior spination, which is usually necessary for the pupa to be able to protrude from the cocoon. Some yponomeutids protrude only the head.

Table 1 summarizes the three fundamental characters noted above for each of the families and superfamilies comprising the microlepidop-

³ The sexual dimorphism in abdominal articulation noted by Hodges (1974) in certain Oecophoridae is one of degree only and while some tortricoid tendencies occur, these do not form a simple apodemal articulation but retain the tineoid rod conformation.

TABLE 1. Characters of Ditrysian Microlepidoptera.

Abdominal Articulation	Superfamily		Larval L-group Setae	Protruded Pupa
tineoid rods	Tineoidea	(2 in <i>Scardia</i>)	3	yes
tineoid rods	Gelechioidea		3	no
tineoid rods	Copromorphaidea	- Copromorphidae	2	no
		Carposinidae	2	no
		Epermeniidae	2	no
		Glyphipterigidae	2	no
tineoid rods	Yponomeutoidea	- Douglassiidae	3	yes
		Argyresthiidae	3	yes
		Yponomeutidae	3	yes
		Plutellidae	3	yes
		Acrolepiidae	3	yes
		Heliodinidae	3	yes
apodemes	Sesioidea	- Immidae	3	yes
		Sesiidae	3	yes
		Choreutidae	3	yes
apodemes	Tortricoidea		3	yes
apodemes	Cossoidea		3	yes
apodemes	Castnioidea		3	yes
apodemes	Zygaenoidea		3	yes
apodemes	Pyraloidea		2	yes

terous Ditrysia. Taken together the three characters provide strong evidence that the glyphipterigids and choreutids have not evolved from a recent common ancestor and, consequently, are distinct families belonging to different superfamilies in our present concept of these higher categories.

Affinities and Rearrangements

Rearrangements I propose for a new classification of the lower Ditrysia are as follows: Glyphipterigidae *sensu stricto* and Epermeniidae transferred from Yponomeutoidea to Copromorphaidea, and Choreutidae and Sesiidae restricted to Sesioidea, with the Copromorphaidea being shifted between the Gelechioidea and the Yponomeutoidea, while the Tortricoidea are placed after the Sesioidea in a linear arrangement altered from that proposed by Common (1970). There are also two Nearctic genera placed in Glyphipterigidae *sensu lato* that will be transferred to Copromorphidae in a future paper: one of the genera was already assigned to Carposinidae by MacKay (1972) based on larval characters, but larval differences from true carposinids apparently apply to Copromorphidae.

Meyrick (1928) was the first to combine Copromorphidae and Carposinidae as a new superfamily, the Copromorphaidea (plus Alucitidae), but the Glyphipterigidae and Epermeniidae were not associated with the

superfamily. The discordances noted above show that the characters of the glyphipterigids *sensu stricto* conform to Copromorphoidea. Their naked haustellum and bisetose larva excludes them from the Gelechioidea. Their bisetose larva and the non-protruded pupa excludes them from the Yponomeutoidea.

The Epermeniidae have the same three major character states as the glyphipterigids, which also places the family outside of Gelechioidea and Yponomeutoidea. There is some doubt about the bisetose pre-spiracular condition of epermeniid larvae since MacKay (1972) noted larvae of an *Epermenia* species to be bisetose, but Forbes (1923) noted another to be trisetose. Common (1970) states that epermeniid larvae are bisetose. My own examination of reared epermeniid larvae in the National Museum of Natural History, Smithsonian Institution, Washington, D.C., produced only bisetose larvae. It may be possible that both bi- and trisetose larvae occur in the family as in Tineidae where *Scardia* larvae are bisetose (Hinton, 1956) while other tineids are trisetose. The bisetose condition appears to be an apomorphic development prevalent in endophagous larvae, although as seen in Table 1, this character is generally conservative enough evolutionarily to serve as a useful character for higher classification. Not all endophagous larvae, however, are bisetose; for example, the trisetose endophagous Sesiidae (MacKay, 1968) among others.

The epermeniids are placed between Carposinidae and Glyphipterigidae because of genitalic features showing affinities to Carposinidae, e.g., the uncus, and because of advanced wing venation and other characters showing a close relationship to the glyphipterigids. Some epermeniids superficially resemble glyphipterigids, for example, the Palearctic *Epermenia pontificella* Hübner. As with the superficial resemblance of some choreutids with glyphipterigids, the Epermeniidae also have wing maculation that could be the result of convergent adaptive strategies as diurnal moths, although it is unclear whether all epermeniids are diurnal. Choreutids and glyphipterigids, as also some similar heliodinids, are diurnal in adult activity.

A distinctive feature of the Copromorphidae and the Carposinidae is the anal pecten of the hind wings, but not all species in these families have this feature (Common, 1970). The raised scale tufts of the forewings also are not found in all species of the families, which otherwise is a distinctive character for both families. Both characters would appear to be apomorphic in these two families and, thus, the lack of either in epermeniids and glyphipterigids should not exclude them from the superfamily. Some Gelechiidae and Oecophoridae (e.g., *Tonica* spp.) also have raised scale tufts on the forewings. The Epermeniidae often have

a scale tuft on the dorsal forewing margin that may indicate an affinity with the raised scale tufts of copromorphids and carposinids, although it may be a peculiarity of many epermeniids.

An interesting cohesive character of the Copromorphoidea is the enlarged spiracles of the prothorax and abdominal segment 8. Spiracles of the 8th abdominal segment also are more dorso-caudally positioned than is usual in Lepidoptera larvae (Common, 1970). While spiracle size is close to normal in Carposinidae (MacKay, 1972), a striking enhancement of this character has been illustrated and described by Moriuti (1960) and Kodama (1961) in the larva of the Japanese species, *Glyphipterix semiflavana* Issiki. The larvae have the spiracles of the 8th abdominal segment not only dorso-caudally positioned but elevated on what look like scoli. The larva of a new *Glyphipterix* species from Florida has protruding and enlarged spiracles as in the Japanese species. Larvae of the glyphipterigid genus *Machlotica* also have this unusual spiracle enlargement. I have examined reared *Epermenia* larvae, and these also showed the protruding spiracles. I have not seen larvae of Copromorphidae and follow Common (1970) in his notes for the family. The character may be apomorphic in endophagous larvae, having some unknown adaptive function. MacKay (1959) noted that tortricid larvae with more caudally positioned spiracles of the 8th abdominal segment invariably were borers, although this apparently does not hold for sesiid larvae (MacKay, 1968). Inasmuch as all Copromorphoidea larvae known thus far have enlarged spiracles to greater or lesser degree, but more than usual for Lepidoptera larvae, it appears to indicate a common ancestor for the four families. The unusual spiracle development of epermeniid and glyphipterigid larvae indicates that these two families are closely related. MacKay (1972) also noted other chaetotaxic characters which show affinities of epermeniids to Carposinidae.

The Copromorphoidea, as arranged in Table 1, have a reduction in wing venation from Copromorphidae to Epermeniidae, while retaining a chorda in Glyphipterigidae and vestiges thereof in Epermeniidae. The presence of the chorda has in the past retained the glyphipterigids and epermeniids in the Yponomeutoidea—the same can be noted for the choreutids—but the wing venation of these two families can be accepted as specializations within the Copromorphoidea.

The Douglassiidae are an anomalous family with little known about their biologies. The larvae are stated to be trisetose (Common, 1970), which I have confirmed in larvae of *Tinagma balteolella* (Fisher von Roeslerstamm). The pupa apparently is protruded at adult ecdysis, although this is unclear from published information. I retain them in Yponomeutoidea pending further investigation on their immature stages.

The family appears to be the most primitive yponomeutoid in relation to such characters as wing venation, a reduced uncus, and no socii. The remaining yponomeutoid families appear to form a monophyletic superfamily and require no further notation in the context of this paper. The most recent research of European and Japanese workers is followed by the separation of *Argyresthiidae*, *Plutellidae*, and *Acrolepiidae* from *Yponomeutidae*. The superfamily progresses to the *Heliodinidae*, which would appear to be the most specialized yponomeutoid family.

The *Choreutidae* and *Sesiidae* have usually been considered in the *Yponomeutoidea*, especially due to their similar wing venation, which is also very similar between the two families, although very specialized in the *sesiids*. In fact, in the "choreutid" genus *Sagalassa* the two families nearly merge, with many species in the genus having hyaline wing areas as in *Sesiidae*. Larvae in at least one Neotropical species, *Sagalassa olivacea* (Busck), appear to be indistinguishable from true *sesiid* larvae (Duckworth & Eichlin, pers. comm.). The naked haustellum and other characters of *Sagalassa* indicate a close relation to *Sesiidae*, but with affinities to *Imma*. Since the *Sesiidae* also have tortricoid apodemes at the abdominal articulation and are otherwise closely related to the *Choreutidae*, although extremely specialized, I follow Brock (1971) in assigning both to a separate superfamily, the *Sesioidea*. Although very specialized, the *Sesiidae* retain ancestral features (e.g., genitalic characters) that allow their placement before *Choreutidae* in a linear arrangement of primitive to advanced.

The Pantropical genus *Imma*, in the past included in the *glyphipterigids*, may be assigned to **Immidae**, new family (type-genus: *Imma* Walker [1859]), the most primitive family of the *Sesioidea*. A thorough revision for a clarification of the true affinities of *Immidae* is needed.

Forster (1954) was the first to combine the *Sesiidae* and *Glyphipterigidae* into one superfamily which he called *Glyphipterygoidea*, but he included the *Glyphipterigidae sensu stricto*. Meyrick (1928) had anticipated Forster by segregating the two families from *Yponomeutoidea* to *Glyphipterygoidea*—which was not followed by other workers—but he included *Heliodinidae* and *Heliozelidae*. Turner (1947) also had relationships mixed among several families, yet it is noteworthy that he seems to have been the first to note a possible relationship between *Sesiidae*, *Glyphipterigidae sensu lato*, and the *Copromorphidae*. Niculescu (1964) also noted a relationship to *Copromorphidae*. Brock (1971) used the name *Aegerioidea*, but since *Sesiidae* is senior to *Aegeriidae* through the relative genus pertaining to each name, *Sesioidea* is the correct superfamily name.

The *Sesioidea* remain distinct from the *Tortricioidea* through larval

characters, wing venation, labial palpi, head vestiture, and genitalic features. Among these characters in the Choreutidae are many tortricoid affinities. The largely tropical genus *Hilarographa*, heretofore considered choreutid, has remarkable genitalic resemblance to Chlidanotinae tortricids from Australia and New Guinea (Diakonoff, XV International Congress of Entomology, August 1976, Washington, D.C.) and, together with the related *Idiothauma* and *Mictopsichia*, will be transferred to Tortricidae in the near future.

The Choreutidae have a peculiar feature in their scaled haustellum, which is characteristic of gelechioids but not of sesiids or tortricoids (the three genera to be transferred to Tortricidae have naked haustellums, as do *Sagalassa* and *Imma* species). The state of haustellum scaling is usually useful at the superfamily level in Lepidoptera classification in terms of cohesive groups of families either having a scaled or a naked haustellum. As with other characters, isolated groups are found not to conform to some major character while otherwise having all the characteristics of the particular taxa they are related to. I believe the situation is the same with choreutids in their character complex between Sesiidae, Yponomeutidae, and Tortricidae. The Pyralidae also are the only pyraloid family having a scaled haustellum. As with the choreutids, the haustellum scaling appears to represent the retention of an ancestral character to some related group (e.g., choreutid relatives in the gelechioids?) or an apomorphy.

Figure 1 illustrates my understanding of the evolution of the Ditrysia by evidence presented herein and arranged linearly, but I do not wish to discuss all the details involved as this has been extensively covered by other authors (see Common, 1975). The taxa shown in the figure have lineage heights in relation to the general amount of evolutionary change (as a rate vector) that the group has undergone from ancestral forms: for example, Yponomeutidae evolved from an ancestral yponomeutoid but at a slower rate than Douglassiidae and, thus, the latter family is placed on a higher rate vector although the douglassiids have other characters which indicate they are more primitive yponomeutoids.

Superfamily Relationships

For a linear arrangement of the ditrysiian microlepidopterous superfamilies, I follow Common (1970) as modified by the studies of Brock (1971). Thus, the Tineoidea and Gelechioidea are considered the most primitive due to their articulation and wing venation. However, such an understanding of their phylogenetic ancestral relationships does not preclude the many specializations found within the Gelechioidea, being a result of differential rates of evolution in the various included families.

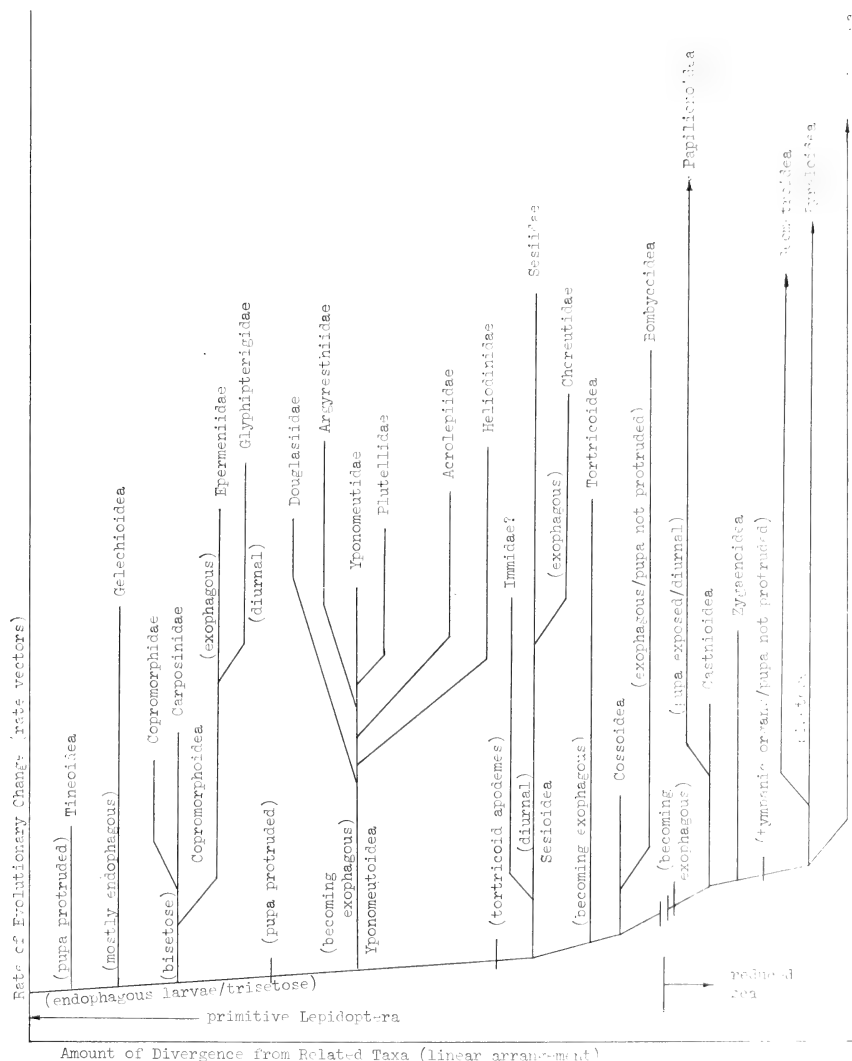


Fig. 1. Evolution of Ditrysia.

In contrast to Common (1970), I place the Copromorphoidea after Gelechioidea due to their tineoid abdominal articulation and the non-protruding pupal behavior, which is not tortricoid. Copromorphids have an abdominal articulation resembling the apodemal type, yet retain the tineoid sternal rods: the apodemal resemblance is actually enhanced due to the stoutness of the rods. The trisetose larvae and protruding pupal

behavior of Yponomeutoidea indicates closer affinities to Sesiioidea than to Gelechioidea, thus, placing them after Copromorphoidea.

The apodemal nature of the abdominal articulation of Tortricioidea is a derived condition and demonstrates closer affinities to the higher Ditrysia, which all have the apodemal articulation, than to the Tineoidea, as followed by Common (1970). Larval studies by MacKay (1959) have also shown that most tortricids are more advanced than Tineoidea. As noted above, the mixed character complexes of the Sesiioidea indicate ancestral relationships to both Yponomeutoidea and Tortricioidea, placing them in the middle in a linear arrangement. The Cossoidea I consider having evolved at a very slow rate of evolution in relation to the related Tortricioidea and, while more primitive in many ways compared to tortricoids, they are more advanced than ancestral tortricoids, thus allowing a more convenient placement after Tortricioidea for a linear arrangement. The remaining superfamilies are arranged after Common (1970) except for the Alucitidae. The alucitids were placed in the Copromorphoidea by Meyrick (1928) and Common (1970) but the tortricoid abdominal articulation would better place them in the Pyraloidea (Brock, 1971), which also have bisetose larvae and non-protruding pupae.

CONCLUSIONS

The long maintained assimilation of the Glyphipterigidae and Choreutidae as one family was due to their overall resemblance. Evaluation of more fundamental characters, as noted above, has elucidated the discordances in considering the two groups as one family in relation to the desire to maintain only monophyletic groupings of related taxa. Actually, the two groups evolved from distinct ancestral lines and must be considered distinct families.

Evaluation of related families indicates that the Epermeniidae are much more closely related to Glyphipterigidae than previously considered, with both showing common ancestry with the Copromorphidae and Carposinidae. Thus, the four families are here considered in one superfamily, the Copromorphoidea. Fundamental characters also distinguish the Sesiidae and Choreutidae as Sesiioidea (together, probably, also with Immidae), not Yponomeutoidea, and their placement between the yponomeutoids and the tortricoids appears sound. Immidae will be discussed further in a forthcoming paper.

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AN "ALBINIC" *PIERIS SISYMBRII* (PIERIDAE) FROM THE CALIFORNIA SIERRAS

"Albinic" or "depigmented" forms largely or wholly lacking melanin pigment from the wings are known in several pierid butterflies. Within the genus *Pieris* a weakly melanized form is known from *P. protodice* Bdv. & LeC. (Shapiro 1970, Wasmann J. Biol. 28: 245–256) and Gardiner (1962, Ent. Gaz. 13: 97–100; 1963, J. Res. Lep. 2: 127–136) has reported a form from *P. brassicae* L. in which the normally black scales lack pigment altogether, producing a translucent "shadow" pattern. In both of these cases the genetics is known. Crowe (1967, J. Lepid. Soc. 21: 121) reported a female *P. sisymbrii* Bdv. from Harney Co., Oregon which seems to resemble Gardiner's form of *P. brassicae* in totally lacking melanin on the wings. Although the accompanying photograph does not show a "shadow" pattern, it is mentioned in the text. On 23 May 1975 a very similar male with "shadow" pattern was taken flying among normal individuals on Washington Road, off state Highway 20 in Nevada Co., California. As in Crowe's specimen, the normally dark wing-veins contrast strongly with the ground color and the body, legs and antennae are normally pigmented. This male was kept alive for two days but no virgin females were available and I could not induce wild females to mate. The Washington Road population is unusual in that it is an isolated colony on the highest-elevation outcrop of serpentine soil (elev. 5000 ft) in the central west-slope Sierra. The vegetation on this atypical site is digger pine-manzanita-scrub oak, contrasting strongly with nearby stands of mixed montane coniferous forest on non-serpentine soils; the nearest known *sisymbrii* colony is seven miles away. This is the first aberrant individual I have seen among about 750 wild *P. sisymbrii* in about 20 California populations.

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TWO NEW SPECIES OF *PETROVA* MOTHS FROM PINE
IN SOUTHEAST ASIA (TORTRICIDAE, OLETHREUTINAE)

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The genus *Petrova* is holarctic in distribution and its known hosts are conifers, pines in particular. The larvae are usually shoot borers. Forest entomological investigations in India and Thailand have revealed two previously unknown members of *Petrova* whose descriptions follow. One of them has adapted to an introduced North American pine in southeast Asia.

In this paper the letter *n* denotes number of specimens underlying an observation or conclusion. Color names accompanied by a parenthetical number indicate standard colors in the system of Kelly & Judd (1965).

For specimens and information I thank Chavewan Hutacherern, Thailand Royal Forest Department, Bangkok; M. J. Chacko and T. Sankaran, Commonwealth Institute of Biological Control (CIBC), Indian Station, Bangalore; and Fujio Kobayashi, Government Forest Experiment Station, Momoyama, Kyoto, Japan.

***Petrova khasiensis* Miller, new species**

Figs. 1a-c

Male. (2 n) *Head*: Labial palpus short, second segment $0.9\times$ eye diameter, apical segment $0.4\times$ length of second segment; scaling spreading, partly obscuring apical segment, orange brown, darker toward base. Scaling of front and crown lighter hued than labial palpus. *Thorax*: Dorsal scaling, including tegulum, shining brown, some scales white tipped. Venter and prothoracic and mesothoracic legs shining brown, metathoracic legs lighter, tibiae and tarsi white banded. *Forewing*: Length 7.0–8.5 mm, $2.6\times$ width; apex acute, termen slightly convex, tornal angle distinct. Upper side (Fig. 1a) with indistinct basal patch, shining gray from base to middle with sprinkling of strong brown, strong brown beyond middle except for four paired white marks on costa, which continue irregularly and intermittently to dorsum as silver and white bands and form a rudimentary ocellus; about 15 black scales sprinkled in ocellar area. Fringe gray, tinged with orange brown. Underside gray, mottled with white in costal area. *Hindwing*: Wider than forewing, termen concave, curved to dorsum, tornal angle not discernible. Shining gray throughout. Fringe pale gray. Underside gray, lighter than underside of forewing. *Abdomen*: Dorsal scaling shining light brown, ventral shining white. Genitalia (2 n) with valva moderately constricted, clasper a broad ridge (Fig. 1b); uncus slightly developed.

Female. (6 n) As described for male with following exceptions. *Forewing*: Length 8.0–9.5 mm, $2.4\times$ width. *Abdomen*: Genitalia (4 n) with sterigma a shield-like plate (Fig. 1c), a sclerotized incomplete ring near middle of ductus, two unequal sized thorn-like signa. Posterior apophyses shorter than anterior.

Types. *Holotype*, male (Fig. 1a) and *allotype*, female: Upper Shillong, Assam

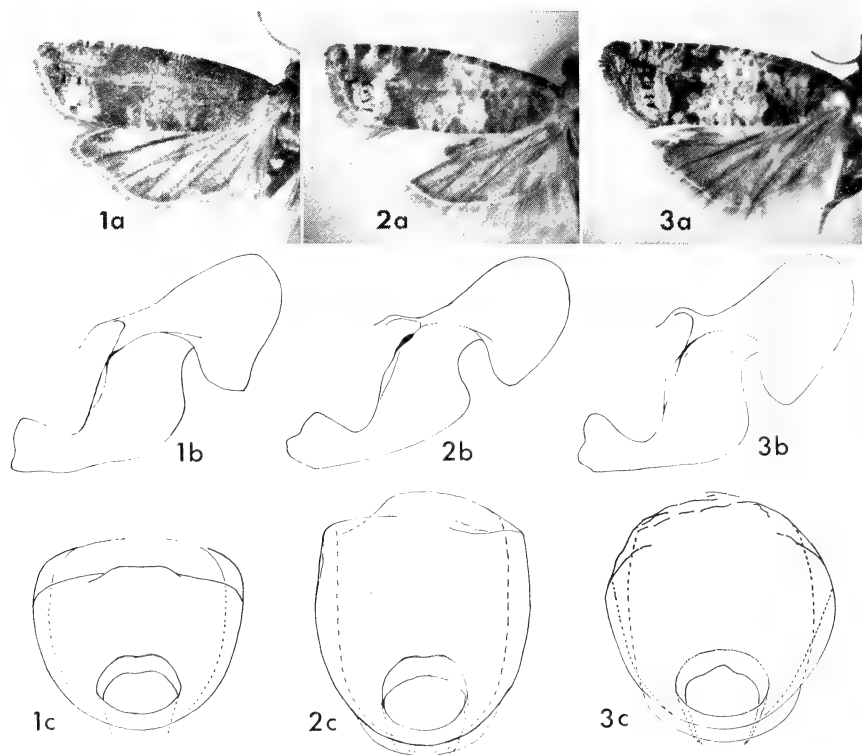


Fig. 1. *Petrova khasiensis*: a. holotype, male; b. male valva; c. female sterigma.

Fig. 2. *Petrova salweenensis*: a. holotype, male; b. male valva; c. female sterigma.

Fig. 3. *Petrova cristata*: a. female from near Kyoto, Japan, forewing length 8.0 mm; b. male valva; c. female sterigma.

(now Meghalaya), March 1963, CIBC, male genitalia slide 173 and female genitalia slide 170 (R. B. Moore) and wing slide II.24.76 (W. E. Miller), both types in US National Museum of Natural History. Two paratypes: same data as holotype except male genitalia slide 376301 (W. E. Miller) in US National Museum of Natural History, and female genitalia slide 412763 (W. E. Miller) in collection of CIBC Indian Station, Bangalore. Four additional females examined, one with same data as holotype, two with same except August 1968.

Host. *Pinus khasya* Royle.

Geographic distribution. Khasi Hills of northeastern India.

***Petrova salweenensis* Miller, new species**

Figs. 2a-c

Male. (4 n). As in *khasiensis* with following exceptions. *Thorax*: Dorsal scaling lighter and sprinkled with strong brown. *Forewing*: Length 6.0–7.5 mm; upper side (Fig. 2a) more heavily sprinkled with strong brown from base to middle, basal patch distinct. *Abdomen*: Genitalia (3 n) with valva greatly constricted (Fig. 2b), uncus moderately developed.

Female. (5 n). As described for male with following exceptions. *Forewing*: Length 6.0–8.5 mm. *Abdomen*: Genitalia (5 n) as in *khasiensis* except sterigma more elongate (Fig. 2c).

Types. *Holotype*, male (Fig. 2a): Baw Luang, Thailand, March 20, 1972, D. Chaiglom; *allotype*, female, Chiangmai, Thailand, March 10, 1975, Chavewan, female genitalia slide 22476a (W. E. Miller), both types in US National Museum of Natural History. Two paratypes: Baw Luang, Thailand, March 1976, Chavewan, male genitalia slide 376305, and female genitalia slide 376304 (W. E. Miller) in US National Museum and Thailand Royal Forest Department, Bangkok, respectively. Five additional specimens examined, two males and three females, same data as paratypes.

Hosts. *Pinus khasya*, *P. merkusii* De Vries, and *P. caribaea* Morelet, the last introduced from North America.

Geographic distribution. Northwestern Thailand.

DISCUSSION

The closest known occurrences of *Petrova khasiensis* and *P. salweenensis* to one another are 960 air km apart. Both species are similar to *P. cristata* (Walsingham) (Figs. 3a–c; illustrated by Issiki (1957) in color) whose nearest known occurrence is Canton, China (Obraztsov, 1964), 1,500 air km northeast of Chiangmai. Both new species were compared with *P. cristata* reared from *Pinus thunbergii* Parl. near Kyoto, Japan (5 n). The main anatomical differences are summarized as follows:

Item	<i>khasiensis</i>	<i>salweenensis</i>	<i>cristata</i>
Forewing (5–9 n):			
Length, mm	7.0–9.5	6.0–8.5	6.0–8.0
Ground color	Strong brown (55)	Strong brown (55)	Dark brown (59)
Basal patch	Obscure	Distinct	Distinct
Male genitalia (2–3 n):			
Ventral margin of valval sacculus	Obtuse angular	Right angular	Right angular
Valval constriction	Moderate	Great	Great
Uncus development	Slight	Moderate	Slight
Female genitalia (3–5 n):			
Width of sterigma	> Length	< Length	< Length

Strong brown is much lighter than dark brown. Color and other anatomical differences between adult *Petrova khasiensis* and *P. salweenensis* are minor, but it is desirable for communication purposes to treat them as separate taxa unless future biological investigations prove them conspecific and reduce the weights of current diagnostic characters.

Pine biogeography suggests how *Petrova khasiensis* and *P. salweenensis* may have evolved. The two species appear to be isolated from one another by disjunct distribution of the shared host, *Pinus khasya* (variously spelled such as *kesiya* and considered by some authors to be *P. insularis*

Endl.). *Pinus khasya* does not occur at low elevations and there are 100-km gaps between its occurrences from the Khasi Hills of north-eastern India (range of *Petrova khasiensis*) to the highlands of Thailand (range of *P. salweenensis*) (Critchfield & Little, 1966; Mirov, 1967). *Pinus merkusii* and other pines likewise seem to be absent in these gaps. In Pleistocene times, the cool climate that allowed pines to migrate southward through Indochina (Mirov, 1967) must have allowed *P. khasya* to occur at low elevations, perhaps in continuous distribution. As the climate warmed at the end of the Pleistocene, *P. khasya* would have retreated from low elevations to form its fractured distribution pattern, thereby creating islands of *Petrova* that speciated. Under this hypothesis, related *Petrova* might occur in other subdivisions of the *Pinus khasya* range.

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A RECORD OF *URBANUS SIMPLICIUS* (HESPERIIDAE) FOR THE USA

Tilden (1965, J. Lepid. Soc. 19: 53-55) summarized the differences between *Urbanus simplicius* (Stoll) and *Urbanus procne* (Plotz). He found that most if not all records of *simplicius* from the USA were erroneous, a result of confusion of that species with *procne*.

I took a fresh male *simplicius* in Bentsen-Rio Grande Valley State Park, Hidalgo Co., Texas, on 13 April 1974. The specimen was collected at a large patch of thistle, *Cirsium texanum* Buckl. (Compositae), whose blossoms were attracting many skippers. Of the 35 species of HesperIIDae present, other interesting species were *Urbanus doryssus* Swainson, *Astraptus anaphus annetta* Evans, *Aguna asander* (Hewitson), *Cogia outis* (Skinner), and *C. hippalus* (Edwards). These are apparently the first records from the Lower Rio Grande Valley for the two *Cogia* species.

I wish to thank the Texas Parks and Wildlife Department for the issuance of a collecting permit for Bentsen-Rio Grande Valley State Park.

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DATA SUGGESTING ABSENCE OF LINKAGE BETWEEN TWO LOCI IN THE MIMETIC BUTTERFLY *HYPOLIMNAS BOLINA* (NYMPHALIDAE)C. A. CLARKE AND P. M. SHEPPARD¹

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A large number of female forms of the polymorphic Batesian mimic *Hypolimnas bolina* (L.) have been described, but the situation is complicated because essentially similar phenotypes have been given different names in different geographical areas. In fact, the forms can be described in terms of four basic phenotypes and their combinations, together with minor modifications of pattern. We have used for the sake of clarity the varietal names for the four main forms given by Poulton (1924). In the present paper we discuss the genetics of three of these, the mimic f. *euploeoides* and two of the three nonmimetic forms, f. *nerina* and f. *naresi*.

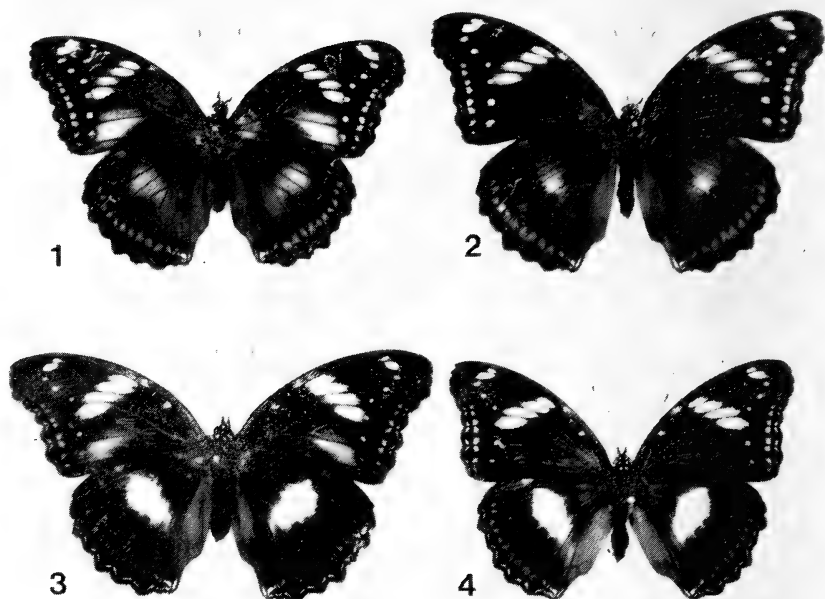
In a previous paper (Clarke & Sheppard, 1975) we showed that this polymorphism, sex-controlled to the female, is determined by two loci, one with two allelomorphs (*E* and *e*) and the other with three (*P*, *P^a*, and *p*). It is possible that the locus with three alleles consist of two very closely linked loci with epistatic interactions between the allelomorphs.

The data used in the previous investigation gave a crossover value between the two loci *E* and *P* of 45.2%, which was not significantly different from independent assortment. Since all the evidence, including that from *Ephestia kuehniella* Z. (Traut & Rathjens, 1973), suggests the absence of chiasmata in female Lepidoptera, and in our broods the double heterozygote was the female, it seemed unlikely that the two loci are on the same chromosome. However, despite the absence of chiasmata in *E. kuehniella*, Robinson (1971) reports a brood in which crossing over had apparently occurred in the female of this species, and it therefore seemed important to investigate the possible linkage between *E* and *P* further. The present paper reports five broods in which the progeny were all female (a phenomenon surprisingly common in *H. bolina* (Clarke *et al.*, 1975)). One of the backcross broods (14228) in which the female was a double heterozygote produced 126 offspring and therefore could give information on linkage.

MATERIAL AND METHODS

Genotypes and corresponding phenotypes. Clarke & Sheppard (1975) list all the genotypes and their corresponding phenotypes. One of these,

¹ED. NOTE: Professor P. M. Sheppard died 17 October 1976. His obituary will appear in the next issue.



Figs. 1-4. Four female offspring of brood 14228. 1. f. *euploeoides-nerina* (genotype EeP^np), wing span 85 mm. 2. f. *euploeoides* ($Eepp$), wing span 89 mm. 3. f. *nerina* (eeP^np), wing span 95 mm. 4. f. *naresi* ($eepp$), wing span 78 mm.

euploeoides-nerina (sometimes called *aphrodite*, Fig. 1) was synthesised on many occasions by crossing both homozygous and heterozygous *euploeoides* ($EEpp$ and $Eepp$, Fig. 2) with *nerina*, again when both homozygous and heterozygous (eeP^nP^n and eeP^np , Fig. 3). However, we never succeeded in showing that a wild *euploeoides-nerina* was in fact carrying both the allelomorph E and the allelomorph P^n , rather than being of some as yet unknown genotype.

In the present experiment the original female sent to us was a wild gravid *euploeoides-nerina* from Sarawak. Her progeny were mated to males from a stock of hybrid origin. These were of the genotype $eepp$, which in the female produces the form *naresi* (Fig. 4), the bottom recessive.

Breeding methods. The butterflies were bred in heated greenhouses in Liverpool using the methods described in Clarke & Sheppard (1975).

TABLE 1. Broods giving linkage data in *H. bolina*.

Brood No.	Provenance and Form of Mother	Provenance of Father	Offspring			
			♂♂		♀♀	
14067	Wild Sarawak <i>euploeoides-nerina</i>	Wild Sarawak	0	17	11 <i>euploeoides-nerina</i> 6 <i>nerina</i>	
14181	14067 <i>euploeoides-nerina</i>	hybrid <i>eepp</i>	0	19	11 <i>euploeoides-nerina</i> 8 <i>nerina</i>	
14187	14067 <i>euploeoides-nerina</i>	hybrid <i>eepp</i>	0	4	3 <i>euploeoides-nerina</i> 1 <i>nerina</i>	
14228	14181 <i>euploeoides-nerina</i>	hybrid <i>eepp</i>	0	126	34 <i>euploeoides-nerina</i> 28 <i>euploeoides</i> 32 <i>nerina</i> 32 <i>naresi</i>	
14229	14181 <i>euploeoides-nerina</i>	hybrid <i>eepp</i>	0	10	2 <i>euploeoides-nerina</i> 2 <i>euploeoides</i> 2 <i>nerina</i> 4 <i>naresi</i>	

RESULTS

Table 1 gives the progeny of the original female and subsequent broods. The first matings at Liverpool were those of two of her *euploeoides-nerina* offspring, which were mated to males of hybrid stock homozygous *eepp*. Two of the resulting *euploeoides-nerina* progeny were again backcrossed to hybrid males *eepp*.

The original female *euploeoides-nerina*, or her wild mate, or both, were probably homozygous for *nerina* (P^nP^n). Thus, brood 14067 appears to be a backcross with respect to *E*. If neither of the parents was homozygous P^nP^n , then one would expect at least one in three of the progeny to be neither *euploeoides-nerina* nor *nerina*. Since no other phenotype (*euploeoides* or *naresi*) appeared, it is likely that at least one of the parents was in fact homozygous P^nP^n . On the other hand, if the wild brood were an F2 for *E*, then the ratio should be at least three *nerina* to four non-*nerina* (*euploeoides* or *naresi*) among those insects that are not *euploeoides-nerina*.

That the wild male was certainly carrying *nerina* is shown by the next generation. His *euploeoides-nerina* daughter (EeP^nP^n) mated to a *naresi* male (*eepp*) (brood 14181) produced no *euploeoides* or *naresi*, showing that she was homozygous *nerina*; her offspring must therefore have been heterozygous (EeP^np and eeP^np). This was confirmed by the second backcross (brood 14228), which segregated *euploeoides-nerina* (EeP^np), *euploeoides* ($Eepp$), *nerina* (eeP^np), and *naresi* ($eepp$)

in a good 1:1:1:1 ratio. The small brood 14229 is also consistent with this ratio. Thus, the series of matings not only shows that a female *euploeoides-nerina* from the wild was in fact produced by the combination of the allelomorphs *E* and *Pⁿ*, but the broods also strongly support the view that the two loci segregate independently and there is no need to invoke crossing over in the female.

Since two of the forms (*nerina* and *naresi*) are nonmimetic, *euploeoides-nerina* is a poor mimic, and only *euploeoides* is a good one, it seems unlikely that the polymorphism is maintained by frequency-dependent selection due to the mimicry alone, particularly in the absence of close linkage. It therefore seemed important to look at other possible selective effects of the allelomorphs, such as viability and speed of development. The present second backcross broods can give us no information on the viability of the *euploeoides* and *nerina* homozygotes. However, they also give no evidence, under laboratory conditions, of differential viability between the four genotypes that could be tested.

There was a suggestion of differential speed of development, with an apparent excess of *naresi* emerging early and butterflies carrying *euploeoides* (*EePⁿp* and *Eepp*) coming out late. However, an analysis of variance revealed no significant differences with respect to the allelomorphs and their interactions, the comparison "*euploeoides*" (*EePⁿp* and *Eepp*) to non-*euploeoides* (*eePⁿp* and *eepp*) giving $0.1 > p > 0.05$, *nerina* (*EePⁿp* and *eePⁿp*) to non-*nerina* (*Eepp* and *eepp*) $p > 0.1$, and the interaction $0.1 > p > 0.05$.

Because two of the probabilities were quite low we investigated similar large broods from Clarke & Sheppard (1975). As in the present brood, an insignificant excess of females carrying *euploeoides* came out late ($p > 0.1$). Clearly, it would be worth investigating the matter further. We could not combine the analyses because under the different conditions of raising the broods the variances in the emergence times were heterogeneous.

SUMMARY

The complicated polymorphism in the mimetic butterfly *Hypolimnna bolina* can be described in terms of the four main phenotypes and their combinations. Genetic analysis from broods bred in the laboratory reveals that these are controlled by two unlinked loci, a matter that was previously in doubt.

No differences in the viability of the four genotypes tested could be detected. Although there was a suggestion that these allelomorphs affected speed of development, the differences were insignificant from the amount of data so far available.

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CAPTURE OF *PAPILIO ANDROGEUS* (PAPILIONIDAE) IN SOUTHERN FLORIDA, A NEW RECORD FOR THE USA

A female *Papilio androgeus* (Cramer) was captured on 22 March 1976 in Broward Co., Florida (Figs. 1-2). The badly worn specimen was captured in an overgrown orange grove adjacent to Flamingo Road, near State Road 84, west of Ft. Lauderdale. I captured the specimen while she rested on weeds beneath the orange trees. According to Barcant (1970, Butterflies of Trinidad and Tobago, London) the main foodplant of the species is the orange tree, *Citrus sinensis* (Osbeck).

Irving Finkelstein and Ray Suydam, reported seeing two males of *P. androgeus* in the same orange grove on 23 March and 27 March, respectively. Charles V. Covell, Jr. saw one male of the same species about 1 mi. W of the above location on 23 May 1976.

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Figs. 1-2. 1, left, female *Papilio androgeus*, upper surface; 2, right, same specimen, under surface.

GENERAL NOTES

DETERMINATION OF SEX IN FOUR SPECIES OF
GIANT SILKWORM MOTH LARVAE (SATURNIIDAE)

We consider the ability to determine the sex of giant silkworm moth larvae to be of applied value from two standpoints. First, we could rear only (or primarily) individuals of the sex required for special research purposes. Second, we could insure that small colonies (≤ 12 individuals), maintained from year to year as breeding stock, contain sufficient numbers of each sex. Except for information reported for the domestic silkworm, *Bombyx mori* Linnaeus (Tazima, 1964, The genetics of the silkworm, Prentice-Hall: Englewood Cliffs, New Jersey), we have found very little information concerning sex determinations in lepidopterous larvae. A recent paper by Hinks & Byers (1973, Can. J. Zool. 51: 1235-1241) reported structures that appear to be reliable indicators of sex in certain noctuid larvae. In female noctuid larvae these characters consist of four pits or other modifications of the integument associated with the developing female genitalia and occur between the ventral and subventral setae on the 8th and 9th abdominal segments; in male noctuid larvae they consist of a pit or other modification of the integument associated with the developing male genitalia (Herold's Organ) and occur on the venter of the 9th abdominal segment. Similar, but less detailed, information has been reported for the genus *Malacosoma* (Stehr & Cook, 1968, Bull. U.S. Nat. Mus., 276: pp 46-47).

During 1975, while maintaining large research colonies of several giant silkworm moth species, we decided to examine some of our colonized larvae to determine whether they exhibited similar sex-related characters. We selected random samples of four giant silkworm moth species (Table 1) and categorized individuals as male or female on the basis of the characters reported by Hinks & Byers. The larvae were then segregated according to sex and reared to pupation or adulthood to confirm the sex of each individual.

Larvae of *Antheraea polyphemus* (Cramer) were examined in both the 4th and 5th instars. We found only the structure related to the developing male genitalia, visible to the naked eye in both instars as a single black pit on the venter of the 9th abdominal segment; female characters were not observed even at 60 \times magnification. Individuals exhibiting this black pit were categorized as males; those without it were categorized as females.

Larvae of *Eupackardia calleta* (Westwood) were also examined in both the 4th

TABLE 1. Larval sex determinations for four giant silkworm moth species.

Species	Number Larvae Examined	Number Categorized Male or Female	Actual Number Male or Female ¹	Probability of Misclassification ²
<i>A. polyphemus</i>	27	10 ♂ 17 ♀	10 ♂ 15 ♀ 2 ♂	0 (0-0.27) 0.12 (0.02-0.34)
<i>E. calleta</i>	33	16 ♂ 17 ♀	16 ♂ 17 ♀	0 (0-0.18) 0 (0-0.17)
<i>H. cecropia</i>	28	15 ♂ 13 ♀	14 ♂ 1 ♀ 13 ♀	0.07 (0.0003-0.3) 0 (0-0.23)
<i>C. promethea</i>	43	21 ♂ 22 ♀	20 ♂ 1 ♀ 22 ♀	0.05 (0.0002-0.21) 0 (0-0.13)

¹ Sex determined by examination of pupae or adults.² Estimates of probability of misclassification and 95% confidence interval.

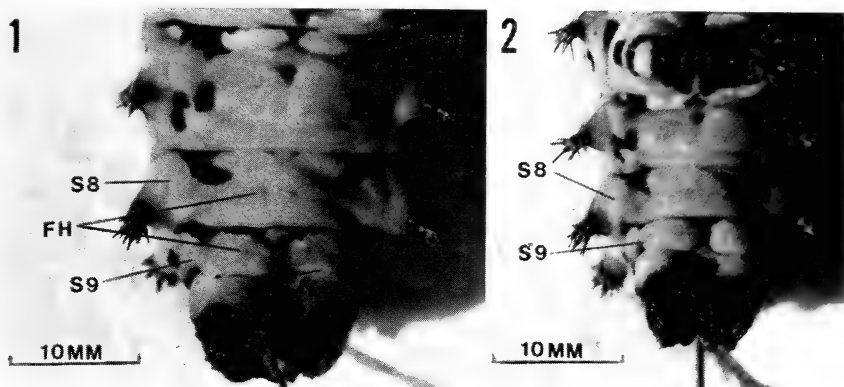


Fig. 1-2. Ventral views of 5th-instar *E. calleta* larvae. 1, female larva showing location of the pits associated with the developing genitalia (FH) on the 8th and 9th (S8 and S9) abdominal segments. 2, male larva showing the absence of these pits on S8 and S9.

and 5th instars. We found only the developing female genitalia, visible to the naked eye in both instars as four prominent dark pits on the ventral side of the 8th and 9th abdominal segments (Fig. 1). We did not observe any male character (Fig. 2), even at 60 \times magnification. Individuals with the four dark pits were categorized as females; all others were categorized as males.

Of the *Hyalophora cecropia* (Linnaeus) specimens, we examined 3rd-, 4th-, and 5th-instar larvae. We found only the developing female genitalia in the 4th- and 5th-instar larvae, visible to the naked eye as four white subsurface spheres on the ventral side of the 8th and 9th abdominal segments. Microscopic examination of the integument over these white spheres did not reveal any pits or other modifications of the surface. Individuals with these white spheres were categorized as females; all others as males.

Larvae of *Callosamia promethea* (Drury) were examined only in the 4th instar. Using the naked eye, we were unable to find any evidence of developing male or female genitalia. However, microscopic examination (60 \times) revealed the presence of developing female genitalia in the form of two obscure, irregular, subsurface, dark green to black bodies on the ventral side of the 8th abdominal segment. There was a slight modification of the integument over these structures. Male characters could not be found even at 60 \times magnification. Individuals with the dark subsurface structures were categorized as females; all others as males.

Our observations (Table 1) demonstrate that the characters associated with the developing genitalia can be used to determine the sex of larvae of these four giant silkworm moth species. When selecting larvae, the probability that an individual will be misclassified depends on how distinct the characters are, the sex in which the characters occur, and the sex being sought. In *A. polyphemus* only the male character was observed. Thus, if one is seeking to obtain only male larvae of this species, the chance of selecting a group free of females is very good, particularly if any questionable individuals are excluded. Conversely, if one is seeking to obtain only female larvae of *A. polyphemus*, the chances are not as good because males with indistinct genital characters might be included with the females. Our findings bear this out for *A. polyphemus* and the other species we studied, although for *E. calleta*, *H. cecropia*, and *C. promethea* the situation is reversed.

In addition to the colonized larvae, we examined five wild larvae of *H. cecropia*

that were collected in the 4th instar and examined only at that stage of their development. We categorized all these larvae as males, but later examination of the pupae showed four males and a female. These results agree with our findings for colonized *H. cecropia* larvae (Table 1).

The findings from this study should be of interest, and perhaps of applied value, to lepidopterists, dealers, and researchers who colonize or study giant silkworm moths.

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A METHOD FOR HANDLING EGGS AND FIRST INSTAR LARVAE OF *CALLOSAMIA PROMETHEA* (SATURNIIDAE)

In an earlier paper (Miller & Cooper, 1976, *J. Lepid. Soc.* 30: 95-104) we reported the use of portable outdoor cages to effect the mating of various giant silkworm moths, including *Callosamia promethea* (Drury). Since that time we have conducted studies to evaluate methods for the collection of eggs and the transfer of newly-hatched larvae to food plants.

We routinely collect eggs from giant silkworm moths by placing fertile females in paper bags where they can oviposit on the inner surfaces. For larvae reared outdoors, we turn the paper bags inside out and place them in sleeve cages already attached to branches. For larvae reared indoors, we cut the bags into small pieces of paper containing the eggs masses, and these are variously attached to food plant cuttings. These methods are not novel and have long been used, with variations, by lepidopterists who colonize giant silkworm moths (Crotch, 1956, *A silkmoth rearer's handbook*, The Amateur Entomologist's Society, London; Taschenberg & Roelofs, 1970, *Ann. Ent. Soc. Amer.* 63: 107-111; Waldbauer & Sternburg, 1973, *Biol. Bull.* 145: 627-641; Dirig, 1975, *Growing moths*, N.Y. State College of Agriculture & Life Sciences). For large-scale indoor colonization of giant silkworm moths we found that the time required to cut around the egg masses and then attach them to the food plants was unacceptable. Therefore, we developed a modified procedure for collecting the eggs and transferring the larvae to food plants. This paper reports our results with *C. promethea*.

We used 12 *C. promethea* females, each placed in a brown paper bag (lunch size) on the first night after mating. The following morning the female moths were removed and the bags, containing the eggs, were folded to their original flattened configuration and held for 8 days. On the 9th day 3 fresh wild cherry (*Prunus*) cuttings, each 15-20 cm long and containing 4-5 large leaves, were inserted into each bag. The tops of the bags were folded over about 1.5 cm and a small hole was made at the crease to allow the stems to protrude about 5.0 cm. The bags were inverted and the stems were placed in water containers. Observations of hatching and migration of larvae to the food plants were made by carefully opening the creased end of the bags and looking inside.

The eggs hatched on the 10th day and the larvae crawled about on the inner surfaces of the bags; a few transferred to the wild cherry leaves, but none of these were observed feeding. By the end of the 11th day most of the larvae had transferred to the food plants and were feeding. Observations were continued through the 13th day after oviposition, but no additional larvae transferred to the food plants after day 11. On the 14th day the bags were removed and cut open to record rele-

TABLE 1. Results of oviposition and larval transfer studies with *Callosamia promethea* (Drury).

Female Number	Number Eggs Deposited	Number Eggs Hatched	Percent Hatch	Number Larvae ¹ Transferring to Food Plant	Percent ² Transferring
1	73	69	94.5	68	98.5
2	71	65	91.5	55	84.6
3	87	82	94.2	45	54.8
4	77	69	86.6	66	95.6
5	57	57	100.0	49	85.9
6	92	91	98.9	46	50.5
7	57	54	94.7	50	92.5
8	16	15	93.7	15	100.0
9	34	32	94.1	28	87.5
10	52	52	100.0	42	80.7
11	40	39	97.5	37	94.8
12	48	44	91.6	41	93.1
	704	669	95.0	542	81.0

¹ By second day after hatching.² Number on food plant/number hatched.

vant data. The wild cherry cuttings, containing the 1st-instar larvae, were placed in rearing cages along with other colonized *C. promethea* larvae and no further records of this group of experimental larvae were kept.

We have concluded from the results obtained with this modified procedure (Table 1) that it is an effective and efficient method for handling eggs and 1st-instar larvae of *C. promethea*. Of the eggs that hatched (95%), 81.0% of the larvae migrated to the food plants within two days. We consider this percent transfer to be very acceptable, in view of the fact that we were able to obtain 542 1st-instar larvae on food plants in rearing containers with only a minimum of effort on our part.

We have also found that this procedure gives acceptable results in obtaining eggs and 1st-instar larvae for the indoor colonization of *Antheraea polyphemus* (Cramer) and *Eupackardia calleta* (Westwood), but we have not collected any detailed experimental data for the transfer of these species to food plants.

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HYPOSOTER FUGITIVUS (ICHNEUMONIDAE) PARASITIC WITHIN MEGALOPYGE OPERCULARIS LARVAE (MEGALOPYGIDAE)

The puss caterpillar, *Megalopyge opercularis* (J. E. Smith), is quite important from the medical standpoint since it is highly poisonous.

On collecting larvae of this species from oak trees (*Quercus*) in New Orleans at the end of June 1976, some were noticed to be distinctly underdeveloped and quiescent. The latter were attached to leaves and measured only 7-8 mm. Most

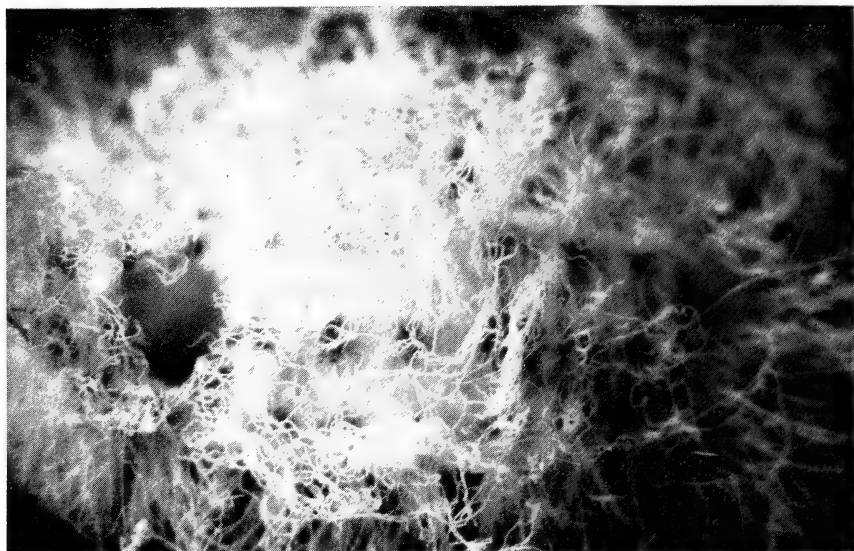


Fig. 1. Remains of parasitized, young caterpillar of *Megalopyge opercularis* showing the hole from which the adult *Hyposoter fugitivus* emerged.

other larvae found at that time measured ca. 20 mm in length. All the larvae were transferred to artificial diet. Three days later, two adults of *Hyposoter fugitivus* (Say) appeared in the container. On the examination of the larvae the parasitized ones were found. Nothing was left of the host except transparent cuticle attached to the leaf of the host plant. There was a 1.5 mm hole between the hairs from which the adult wasp emerged (Fig. 1). The wasp is parasitic on young puss caterpillars. Parasitism apparently resulted in the paralysis and death of the larva, which accounts for their underdevelopment. The parasite pupated within the host and emerged as adult.

Cocoons of puss caterpillar are known to be parasitized by an ichneumonid wasp. However, this is the first record of an ichneumonid wasp parasitic on the larvae of this host.

I am grateful to Dr. R. W. Carlson, Systematic Entomology Laboratory, IIBIII, for the identification of the wasp.

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WOODPECKER FEEDING ON *CALLOSAMIA PROMETHEA* (SATURNIIDAE) COCOON

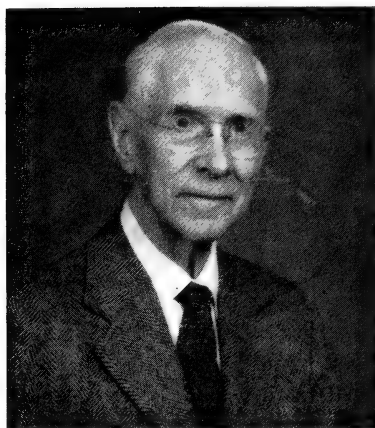
About midday on 15 March 1975, while on a combined bird-walk and cocoon hunt along Bean Creek, near Morenci in Lenawee Co., Michigan, I observed a Downy Woodpecker, *Dryobates pubescens medianus* (Swainson), feeding on a live *Callosamia promethea* Drury cocoon. The day was bright, although cloudy, with temperatures in the forties—ideal weather for such activities. My attention was

drawn to the woodpecker as it landed in a Wild Black Cherry, *Prunus serotina* Ehrh., approximately 25 ft above the creek bank. I focused my 6-12 × 32 zoom binoculars on the woodpecker and observed that it had spotted the suspended cocoon about 2 ft away on a small lateral branch. It then flew to the cocoon, landed on the lower end and proceeded to peck into the cocoon. The woodpecker was clinging upside down while it fed on the cocoon from 1202-1209 EST, and then flew away. While I was observing this predator, another Downy Woodpecker flew into the same tree about 3 ft above the first one. It had spotted another *C. promethea* cocoon and studied it for about one minute before flying away without actually landing on the cocoon as had the first woodpecker.

After retrieving both cocoons and cutting them open, I found that the first woodpecker had completely emptied the pupal contents through a hole about 2 mm in diameter at the thickest part of the cocoon, while the other cocoon contained a parasitized pupa. One can only speculate how these woodpeckers can discriminate between cocoons containing live or dead pupa prior to actually pecking and penetrating the cocoon! Waldbauer et al. (1970, Ann. Ent. Soc. Amer. 63: 1366-1369) reported Downy and Hairy Woodpeckers, *D. villosus* (L.), feeding on cocoons of *Hyalophora cecropia* (L.) under field and captive conditions. Their observations suggest that woodpeckers may, without making a hole, identify cocoons that contain live pupae. They also reported evidence, although no field observations were cited, of woodpecker attacks on *Antheraea polyphemus* (Cramer) and *C. promethea* cocoons.

This was my first observation of cocoon predation in 30 years of field experiences in Michigan, although several other saturniid cocoons have been found which show evidence of woodpecker attacks. It would appear that similar field observations are either rarely made or reported by lepidopterists.

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OBITUARY

ARTHUR H. NAPIER (1895-1976)

Arthur H. Napier, a charter member of The Lepidopterists' Society died 1 November 1976 at the age of 81. Arthur was a graduate of Chestnut Hill Academy, Philadelphia, in 1913 and of Haverford College in 1917. He was a member of a number of learned societies and clubs, here and abroad, but his interest was focused on youth activities. He was a Merit Badge Counselor for the Philadelphia and Valley Forge Council of Boy Scouts of America and received the Award of Merit for his work in scouting. He will be remembered by the many younger people for his interesting Lepidoptera and other insect lectures that he gave for many years in the township schools near his home. Arthur was married to Elizabeth Doyle who died in 1966. In 1968 he married the former Eleanor M. McConnell who had made his lecture appointments in one of the schools where she was employed. Besides his wife Eleanor, the others who survive him are: Arthur H. Napier, Jr., a son; two grandchildren, Constance Fraser and Arthur H. Napier, 3rd; three great-grandchildren, Elizabeth and Alison Fraser, David Groton Napier, and a stepson Leonard Sheppard.

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BOOK REVIEW

REVISED CATALOGUE OF THE AFRICAN SPHINGIDAE (LEPIDOPTERA) WITH DESCRIPTIONS OF THE EAST AFRICAN SPECIES, by R. H. Carcasson. 2nd Edition, 1976. E. W. Classey Ltd., Faringdon, England. 148 p., illus. + 17 plates. Price: \$11.95 (U.S.) paperback.

This publication was originally published in 1968 in the *Journal of the East Africa National History Society and National Museum*, Nairobi, Kenya, and as far as I can see is an unchanged reprint, now in form of a monograph. It therefore contains, of course, again the systematic weaknesses pointed out already by Hodges (1971, The moths of America north of Mexico, fasc. 21). The introduction of the subfamily names "Asemanophorinae" and "Semanophorinae"—although the author himself admits that the correct name of the former should be Smerinthinae—is unfortunate as they are contrary to the rules, notwithstanding the fact that the grouping into two subfamilies is the right thing to be done. The names then should be with Hodges (1971): Sphinginae and Macroglossinae.

In naming his tribes: Ambulicini, Acherontiini, Dilophonotini, Philampelini, and Choerocampini the author tries to keep the connection with Rothschild & Jordan (1903, Novit. Zool., vol. 9, suppl.). Today one would prefer to call them with Hodges (1971): Smerinthini, Sphingini, Dilophonotini, Philampelini, and Macroglossini. The breaking down of the tribes into subtribes is appropriate and even possible rightfully in accordance with the Code of Zoological Nomenclature which admits in article 35 "any supplementary categories required." In North America, however, one usually forms subtribal names on the ending -iti, e.g. Sphingiti instead of Carcasson's "Sphinges."

If the single Hawaiian species (*Tinostoma smaragditi*) taken on p. 7 into the subtribe "Philampeli" is a member of the subfamily "Semanophorinae" at all it is still an unsolved riddle. The palpus has certainly no sensory hairs as found in *Eumorpha* (= *Pholus*). This is now known quite thoroughly after examining more specimens of the species that have come into collections. It may well be that the genus *Tinostoma* (perhaps together with *Sataspes* which also lacks sensory hairs on its palpus) takes a kind of an intermediate position between the two acknowledged subfamilies, at least as far as the labial palpus is concerned.

Interesting and to be commended is the line drawing of the wing pattern of a sphingid (p. 9) and the distributional tables for the tribes and subtribes resp. given in the general part (p. 2-9). They are based for the African species on Carcasson's present work, for the other ones on Rothschild & Jordan (1903).

The main part comprises p. 11-133 and is accompanied by 17 plates of adults (pl. 1-10), genitalia (pl. 11-17), and some immatures on pl. 16. The plates of the adults and immatures are all in black and white halftones that in most cases give a pretty good idea of the appearance of the moths in question. The genitalia are mostly halftones from microscopic slides, sometimes therefore difficult to interpret (alcohol preparations should be used exclusively for such purposes). Some of them are retouched, especially those of females. Overall the photographs are too small, especially of the aedoeagi. Pl. 17 and an unnumbered plate between p. 12 and 13 as well as a single drawing on p. 67 shows genitalia by use of linedrawings. The difference is apparent at once. The costs of publication may have been a hinderance to general use of linedrawings. Certainly in any case all the genitalia on the plates are still preferable to the ones in Rothschild & Jordan.

To go deep into the main part would exceed the scope of this review. Only some remarks should be made: On p. 52 the generic name *Herse* has to be changed to *Agrius*, and on p. 111 the name *Celerio* to *Hyles* for well-known reasons.

Carcasson creates in this work 12 new genera for 29 species and describes 7 new species. For one species a preoccupied name is replaced (*Hippotion griveaudi* for *Hippotion albolineata* Griveaud). There are also four new "subspecies" described

among which at least one, so it seems to me, deserves specific status based on the strong differences of the genitalia, as far as illustrations show (*Polyptychus (andosus) amaniensis*). In another "subspecies" (*Hippotion rosae guichardi*) the illustrations do not bear out what is said in the text. *H. rosae rosae* should be larger than *r. guichardi*, but, in the illustrations it is exactly the opposite. A scaled marker on the photographs would have been useful.

Additions to the general distribution of 3 species have to be made: *Deilephila nerii* add Japan, Hawaii; *Hyles lineata* add Hawaii, Solomon Islands; *Hippotion celerio* add Papuasias, Polynesia (partially).

Hippotion isis is also represented in the Carnegie Museum and labelled "India." It does not seem to be a hybrid, much more it seems to stand in a similar relation to *H. celerio* as *H. swinhoei* to *H. velox*. The wing pattern is as in *H. chloris*, only that the color is uniformly clayish.

The references at the end show that there are really only very few publications available about African sphingids, and only 4 of more recent date for Nigeria, Madagascar, Congo (Brazzaville) and Central and South Africa. With Carcasson's work the whole of Africa is in the moment quite well covered: it also lists and provides information on species not from East Africa. Throughout the whole work are valuable systematic clarifications, e.g., in the dividing of the previously "compound" genus *Polyptychus* into separate entities.

A good and useful glossary follows, and after it is an index that shows where to look for illustrations of species not illustrated here.

There are only very few printing errors (like "HIPPOTRION" on p. 121), as far as I can see. The only one of systematic importance is found on p. 5, line 22 from above, where one has to read "*Asemanophorae*" (italics mine) instead of *Semanophorae*.

To sum it all up: It was a good deed of the publisher to make this worthy work again accessible to the entomological community. It is only in this way that we finally will be able to build up a sufficient knowledge of the Sphingidae of the world.

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——— 1961a. Some contributions to population genetics resulting from the study of the Lepidoptera. *Adv. Genet.* 10: 165–216.

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SELECTION OF THE COCOON SPINNING SITE BY THE LARVAE OF *HYALOPHORA CECROPIA* (SATURNIIDAE)¹

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The univoltine *Hyalophora cecropia* (L.) overwinters as a diapausing pupa in a silken cocoon that is usually anchored to a woody plant. Some are well above ground level on the branches of deciduous trees or shrubs, but most are near the ground among the stems of deciduous shrubs, among adventitious shoots at the base of a deciduous tree, or on an evergreen shrub. After leaf fall, cocoons on bare branches are clearly visible. Cocoons near ground level are usually hidden by grass, debris, or evergreen foliage.

The location of a cocoon significantly affects the probability that it will be found by a vertebrate predator during the winter, and largely determines the species of predator that will find it. In residential areas of Champaign and Urbana, Illinois, from 86.5%–90.9% of the high cocoons were destroyed by woodpeckers, while cocoons low in shrubs or shoots were almost exempt from predation (Waldbauer & Sternburg, 1967b; Waldbauer et al., 1970; Scarbrough, 1970). In rural habitats, not only are most pupae in cocoons on bare branches killed by woodpeckers, but those near ground level may be killed, although less frequently, by mice of two species, *Peromyscus leucopus noveboracensis* (Fisher) and *P. maniculatus bairdii* (Hoy & Kennicott), which do not occur in urban and suburban areas (Scarbrough et al., 1972) (see also Marsh, 1937).

There is little literature on the behavior which leads to the selection of a spinning site by cecropia, no quantitative data on whether or not the larvae migrate from the food plant before spinning, on the extent of migrations, and on whether or not the migrations are affected by the

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growth form of the host plant. We examined the behavior of cecropia larvae during the period which begins with the cessation of feeding and ends with the beginning of spinning. We are particularly concerned with the effects of the environment, especially plantings in urban and suburban residential areas, where cecropia is most abundant in central Illinois.

Cecropia larvae feed on many species of deciduous plants, almost all woody and including both shrubs and trees (Ferguson, 1972; Scarbrough et al., 1974). Feeding larvae are relatively sedentary and seldom leave the host plant (unpublished observations). Cocoons may be anchored to shrubs or trees which are known hosts of cecropia, but a significant number is found on plants, usually shrubs, which are not eaten by cecropia larvae (Waldbauer & Sternburg, 1967a; Scarbrough et al., 1974), indicating that some larvae leave the host plant before spinning.

MATERIALS, METHODS, AND RESULTS

The larvae used in these experiments, progeny of locally collected pupae, were reared outdoors under nets on *Malus pumila* Mill. (apple), *Prunus serotina* Ehrh. (wild black cherry), *Acer saccharinum* L. (silver maple), or *Cornus stolonifera* Michx. or *C. alba* L. (shrubby dogwoods) as described by Waldbauer & Sternburg (1973). Experiments and sampling were done on the University of Illinois campus or residential areas in Champaign and Urbana, Illinois.

Larvae transferred to trees or shrubs were always fifth instars which would continue to feed for at least four or five days before wandering off to spin their cocoons. They almost invariably completed the feeding phase within a few feet of the twig to which they had been transferred.

Expt. I. Emptying the gut and moving to the spinning site.

Feeding larvae reared on apple, silver maple or wild black cherry were transferred for observation to an unnetted tree of the same species, with no shoots at its base. They were placed singly on branch tips at the outer edge of the crown. Each morning they were counted and then watched continuously from 0500–1900 hours. We recorded relevant behavior and the time at which it occurred. At the end of the day larvae which had left the tree were replaced with new larvae.

Mature larvae emptied the gut before moving to a cocoon spinning site, clinging from the underside of a branch by the thoracic legs and the first two or three pairs of prolegs, and allowing the end of the abdomen to hang free. They first passed dry, black feces, then progressively softer greenish feces, and finally a transparent, gelatinous liquid. When finished they crawled away on the upper side of the branch.

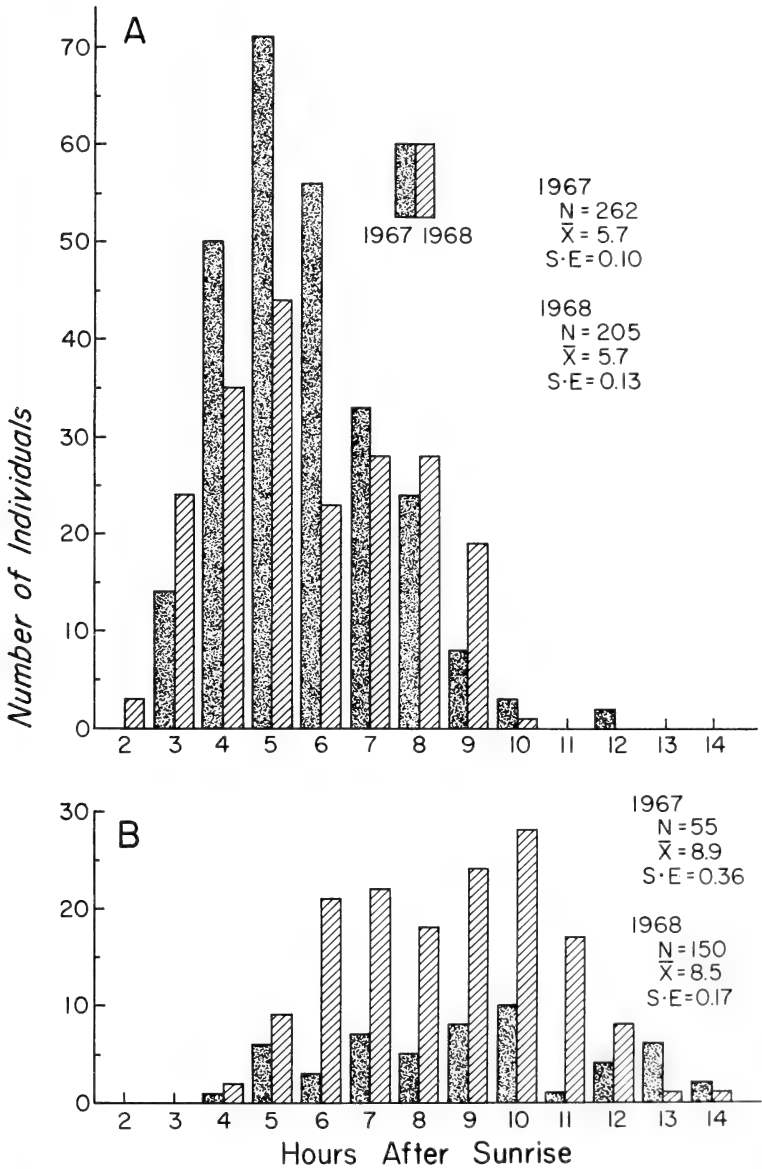


Fig. 1. The times at which cecropia larvae began to empty their guts (A) and the times at which they began to spin the cocoon (B). Times have been rounded off to the nearest hour after sunrise.

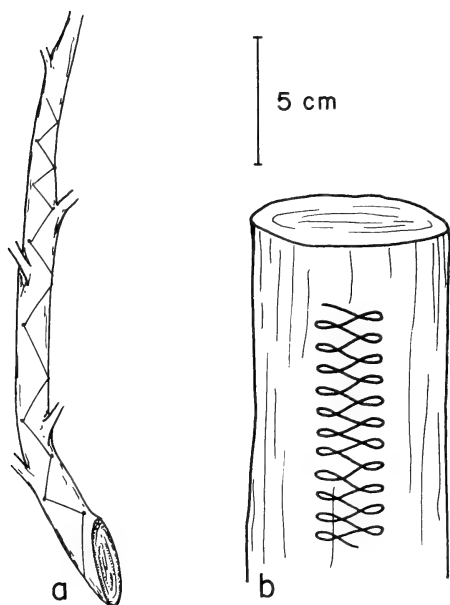


Fig. 2. Diagrammatic representation of the trails of silk left by wandering cecropia larvae on a thin branch (a) and a wide branch or trunk (b).

Gut emptying always occurred during daylight, most larvae beginning between 3 and 9 hours after sunrise, the mean being 5.7 hours after sunrise in both 1967 and 1968 (Fig. 1A). The process required from 15–130 minutes, a mean and S.D. of 38 ± 19 .

After emptying their guts, they quickly moved to the trunk and crawled downward, often diverging onto side branches, but usually returning to the trunk and the downward path. Some spun in the tree (see below), but most descended to the ground.

They swung the head and thorax from side to side as they crawled, leaving a zig-zag trail consisting of a single strand of silk (Fig. 2). This motion is similar to the "swing-swing" reported as a component of cocoon construction, but not of crawling, by van der Kloot & Williams (1953a, b). On very small branches or rough bark the larvae obtained a secure hold and crawled rapidly, leaving a spread-out pattern (Fig. 2a). On larger branches with smooth bark they crawled slowly and left a compressed pattern (Fig. 2b). Ten larvae timed on a 1 cm diameter branch crawled at a mean rate of 78.0 cm per minute, while 10 others, timed on a smooth-barked branch 5 cm in diameter, crawled at a mean rate of 3.0 cm per minute.

Larvae descending large, smooth-barked branches or trunks, often paused at small branches or areas of rough bark, continuing to deposit silk with the swing-swing movement, and sometimes pausing long enough to form a thin sheet of silk. Although we did not see it happen, this might lead to the spinning of a cocoon. Indeed, in a sample of 323 cocoons from small silver maples or birches (not including cocoons from shoots at the bases of the trees), 26% had been spun on small patches of rough bark or at the base of small branches on the predominantly smooth-barked trunk and large branches.

Fig. 1B includes larvae that left the tree in search of a spinning site. Their wandering phase usually lasted from less than an hour to 8 hours; mean \pm S.D. were 3.8 ± 1.8 hours in 1967 and 3.2 ± 1.3 hours in 1968. They began to spin cocoons from 4–14 hours after sunrise, the means being 8.9 and 8.5 hours after sunrise in 1967 and 1968 respectively (Fig. 1B). Spinning usually began on the same day the gut was emptied, but on a few unusually cool days migrating larvae rested on a woody plant from late afternoon until they resumed wandering the following day.

We found, as did van der Kloot & Williams (1953a), that wandering larvae often pass locations which appear to be suitable for cocoon construction. This was exemplified by 40 larvae of Expt. IV that we timed after they had descended a tree with many adventitious shoots at its base. They eventually spun among these shoots, but first spent from 15–215 minutes ($\bar{x} = 70$) crawling among them. The wandering phase and the cocoon construction phase blend into each other since both involve the deposition of silk.

Expt. II. Selection of the spinning site by larvae feeding in shrubs.

We used 5 sites of two types. Two sites were single shrubs of *Cornus stolonifera* on mowed lawns and at least 10 m from any other woody plant. Three sites were rows of 70 or more contiguous, alternating *C. stolonifera* and *C. alba* on lawns. In one of these rows *Viburnum* sp. and *Malus* sp. were regularly interspersed.

About once a week 5 feeding fifth instars, reared on one of the two species of *Cornus*, were released in each isolated shrub and at four widely separated points in each row. The larvae were marked with a distinctive color for each release point. The following October all cocoons were collected from these sites and their locations noted. The release point of the larva which spun each cocoon was determined by eluting in xylol the marker color from the exuviae in the cocoon (Scarborough et al., 1970).

Sixty larvae were released on the isolated shrubs, but 2 were found dead. Cocoons of 51 (88%) of the survivors were found on the shrubs

TABLE 1. Location of cocoons of *Hyalophora cecropia* collected within a 9 m radius of host trees in residential areas of Champaign and Urbana, Ill. (Expt. III).

Location	Cocoons collected:							
	1967-1968		1968-1969		1969-1970		Total	
	No.	%	No.	%	No.	%	No.	%
Grass or shoots at trunk base	45	14.8	137	17.2	254	36.5	436	24.3
Shrubs	148	48.8	343	43.1	242	34.8	733	40.8
Total not in trees	193	63.7	480	60.4	496	71.3	1,169	65.2
Total in trees	110	36.3	315	39.6	200	28.7	625	34.8

on which they had been released. One of the 7 missing cocoons was at the base of a tree about 9 m away, but the other 6 were not found. Ninety larvae were released in the rows of shrubs. All of their cocoons were found and identified. Only 9% had left the row to spin on nearby shrubs or trees. Thirteen percent spun on the same shrub on which they had been released, 62% on a shrub within 4.6 m in the row, and 16% on a more distant shrub in the row.

The fact that these larvae spun near the release site does not mean that they did not wander just before spinning. We watched some of them, and they crawled about at the base of the shrubs for a long time. The shrubs afford ample shade and the numerous closely-spaced stems provide a multitude of potential spinning sites. Thus, negative phototaxis and positive thigmotaxis probably kept the wandering larvae in the cover of the shrubs. If they did wander away, they were probably led back by a visual response to the silhouette of the shrub (see Expt. VI). Indeed, two marked larvae were seen returning to the isolated shrub on which they had fed.

Expt. III. The proportion of larvae which leave the host tree to spin.

We estimated this proportion by searching for wild cocoons in plantings on lawns with host trees for cecropia that were relatively isolated from other trees, but were near shrubs which cecropia larvae do not eat (Scarborough et al., 1974). All plants and structures within 9 m of the tree were searched for cocoons. The number and location of the shrubs varied, but in most cases there were from 1-3 shrubs within 2 or 3 m of the tree. From past experience we knew that in similar situations few cocoons are found more than 9 m from the host tree.

Less than 35% of the cocoons were on the branches of the host tree, but over 65% were on adventitious shoots or tall grass at the base of its

TABLE 2. Number and percent of *Hyalophora cecropia* larvae which spun cocoons in trees with two different growth forms after feeding in these trees at different heights above the ground (Expt. IV).

Foliage type	Height of larvae (m)	No. larvae	Larvae which:			
			Spun in tree		Left tree	
			No.	%	No.	%
Dense canopy & drooping branches	3	40	7	17.5	33	82.5
	6	40	9	22.5	31	77.5
	9	40	17	42.5	23	57.5
	Total	120	33	(27.5%)	87	(72.5%)
Thin canopy & horizontal branches	3	40	10	25.0	30	75.0
	6	40	12	30.0	28	70.0
	9	40	13	32.5	27	67.5
	Total	120	35	(29.2%)	85	(70.8%)

trunk, or on shrubs within 9 m (Table 1). The proportion of cocoons found off the trees is a little lower than might be suggested by the results of Expt. IV (Table 2). This probably reflects differences in sampling techniques. In Expt. IV we accounted for all larvae as they left the trees. However, counting cocoons in the sampling areas probably underestimated the number of larvae which left the trees because cocoons are easier to find in trees than in shrubs, because some larvae probably spun beyond the 9 m limit, and because some wandering larvae were probably killed before they spun a cocoon.

Adventitious shoots at the base of the host tree are the preferred spinning site of larvae which migrate from trees. In sample areas where such shoots were present, 83.3% of the cocoons found off the tree were on them. Where the host tree had no basal shoots, 13.1% of the cocoons off the tree were in tufts of grass at the base of the trunk; the remainder were in nearby shrubs.

Expt. IV. Effect on cocoon site selection of the tree's growth form and the height at which the larvae feed.

We used two isolated silver maples on lawns. Both were about 12 m tall and had trunks extending about 2.4 m from the ground to the bases of the bottom branches. One had dense foliage, numerous drooping branches which shaded the trunk and ground all day, and adventitious shoots at the base of the trunk. The other had sparse foliage and relatively few branches, which were mostly horizontal; the trunk and several major branches received direct sunlight; there were no basal shoots.

Feeding fifth instars reared on silver maple were placed in these trees at heights of 3, 6, or 9 m after being marked with a color indicating the height. Y-shaped twigs with the larvae clinging to them were hung in the tree with a long cane pole. The larvae crawled to the leafy tip of a nearby branch (at approximately the intended height) and fed there until they moved to the spinning site. No more than 5 larvae were ever at the same height on one tree at the same time. During daylight the larvae were watched almost continuously, and the number with each color marking that left the tree was noted.

The number of larvae which remained in the trees to spin, 27.5% on one and 29.2% on the other (Table 2), did not differ significantly. However, on the tree with a dense canopy and drooping branches, the greater the height at which the larvae had been placed, the less likely they were to leave the tree ($\chi^2 = 7.02$, $P < 0.05$), while on the tree with a sparse canopy and horizontal branches, their height did not significantly affect the probability that they would leave the tree to spin ($\chi^2 = 0.56$, $P > 0.975$) (Table 2).

Almost all larvae which remained in the trees spun low in the crown, near where the lower branches join the trunk, no matter at what height they had been placed. We found a similar distribution in a sample of 404 wild cocoons collected from the branches of trees during the winter of 1968-69. Ninety-seven percent were within a spherical volume with a 2 m radius that centered on the point where the trunk and lower branches join. Seventy-eight percent were within a concentric volume with only a 1 m radius. The lower portion of these volumes included drooping branches.

The results of Expt. IV raise the question of why high larvae were less likely than low larvae to leave the densely foliated tree, but not the sparsely foliated tree. Van der Kloot & Williams (1953a) postulated that during the wandering phase some internal event must occur before the larva can begin cocoon construction. The occurrence of this event may be a function of time or metabolic or hormonal processes. Larvae which reached the lower crown from the highest release point had expended more time and effort in wandering than the others, and, therefore, were presumably more internally motivated to stop wandering and spin a cocoon. We suggest that the summation of two factors, internal motivation and satisfaction of the larvae's spinning requirements, was more likely to end the wandering phase in the densely foliated tree than in the sparsely foliated tree, perhaps because the larvae are negatively phototactic.

As in Expt. III, shoots at the base of the host tree were the preferred spinning site. Eighty-four of 87 larvae (96.5%) spun among the shoots at

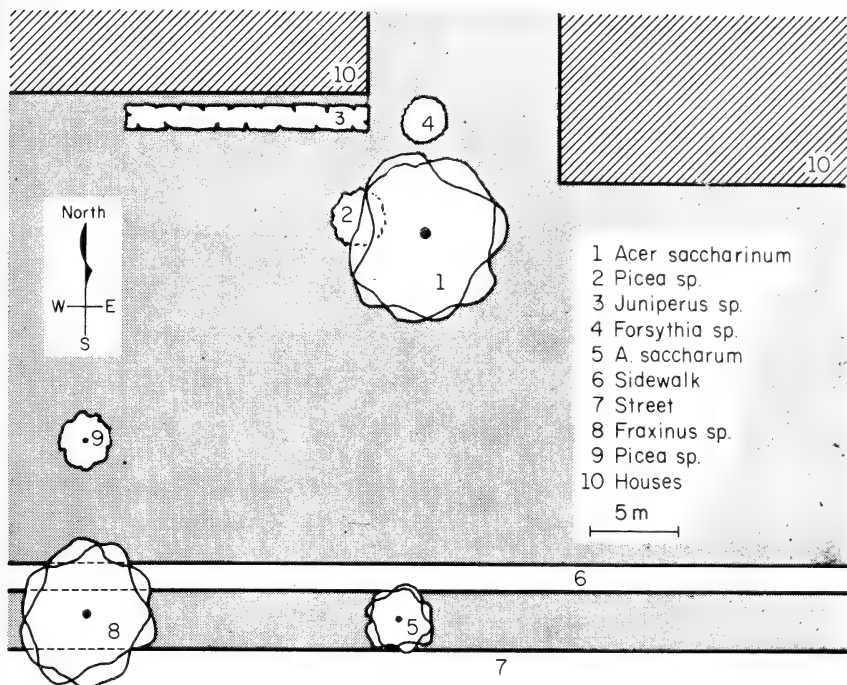


Fig. 3. Diagram of the site of Expt. V, showing residential plantings.

the base of the tree which had them, but only 6 of 85 larvae (6.9%) spun in tufts of grass at the base of the other tree.

Expt. V. Distance from the host tree to the spinning site.

The experimental area was a closely mowed lawn with a silver maple and a number of other shrubs and trees at distances of from 3 m to 23 m from the base of its trunk (Fig. 3). There were no adventitious shoots or tall grass at the base of the silver maple. Eight groups of 10 feeding fifth instar larvae, reared on silver maple, were placed on the lower branches of the silver maple at 6-day intervals. The larvae were marked as described above. They were watched continuously during daylight, and the behavior and route of each migrating larva were recorded.

All larvae left the tree, although two eventually returned to spin on its branches. Seventy-five percent moved more or less directly to the closest spinning site, a spruce (*Picea* sp.) about 3 m from the base of the trunk (Fig. 3). Most of the others moved in the general direction of other shrubs, turning directly toward them when they came within about 1 m.

TABLE 3. Spinning sites chosen by *Hyalophora cecropia* larvae which left the host tree (*A. saccharinum*) (Expt. V). See Fig. 3 for code numbers and locations of the spinning sites.

Spinning site	Meters from trunk of host tree	Larvae spinning:	
		No.	%
<i>Acer saccharinum</i> (1)	0	2 ^a	2.6
<i>Picea</i> sp. (2)	1.2	43	55.8
<i>Forsythia</i> sp. (4)	2.4	5	6.5
<i>Juniperus</i> sp. (3)	3.0	17	22.1
<i>Picea</i> sp. (9)	10.0	2	2.6
<i>Fraxinus</i> sp. (8)	13.7	6	7.8
<i>A. saccharum</i> (5)	9.8	0	0
House (10)	—	2	2.6
Total		77 ^b	

^a These larvae left the tree and returned.

^b Does not include 3 larvae which left the experimental area.

A few moved toward the southeast where there were no shrubs; after moving about 2.5 m from the trunk they turned either north toward the house or south toward the closest tree.

Over 84% of the larvae spun on one of the three woody plants closest to the tree, 56% on the small spruce, the closest spinning site (Table 3). Only 3 left the experimental area. They crawled into the street and were lost.

Expt. VI. Spinning site selection by larvae in trees with no other spinning sites nearby.

The experimental site was a closely mowed lawn with a silver maple 46 m from the nearest other woody plant. There were no shoots or tall grass at the base of the tree. Eighty marked fifth instars that would continue to feed for several days were released and observed as described in Expt. V.

All 80 larvae left the tree. However, 73 of them (91.3%) eventually returned to spin on its branches. Six others climbed trees about 46 m away and spun on their branches. The remaining larva crawled about 37 m to the street and was lost.

They crawled in a more or less straight line away from the trunk of the host tree, occasionally stopping to wave the head and thorax from side to side as if they were trying to get a visual fix on some object. They crawled from 1–25 m (\bar{x} = 9.5 m) before returning to the tree. They always took a somewhat different path on the way back, indicating that they did not follow a silk or an odor trail, and suggesting that they used visual cues to orient to the tree.

TABLE 4. Response of wandering *Hyalophora cecropia* larvae to black or white models presented either alone or simultaneously (Expt. VII).

Models presented	No. larvae tested	Larvae moving to:			
		Black model		White model	
		No.	%	No.	%
Black alone	40	36	90.0	—	—
White alone	40	—	—	29	72.5
Black & white simultaneously	40	34	85.0	5	12.5

Expt. VII. Orientation of migrating larvae to models.

We tested the possibility that migrating larvae visually orient to tree trunks or shrubs, determining their responses to flat cardboard models which approximated the silhouette of a low juniper shrub. They were 0.9×1.5 m rectangles painted either white or flat black. We tested 120 larvae which had been placed in an isolated tree on an otherwise bare lawn a few days before the end of the feeding phase. They were tested only after they left the tree spontaneously. After a larva had crawled about 3 m from the tree, a model or a pair of models side by side, was placed a few meters ahead of the larva, parallel to, and about 1 m to the side of its anticipated path. The experiments were done on sunny days with the models placed so that their shadows were cast away from the larvae.

The response of the larvae (Table 4) leaves no doubt that visual cues are an important component in finding spinning sites. There was a strong response to either the black or white model presented alone, although fewer larvae went to the white model. When black and white models were presented simultaneously, 97.5% of the larvae responded, 85% going to the black model.

Positive responses usually consisted of abrupt changes in direction, the larva usually moving to the edge rather than the center of the model. If a model was moved while a larva was approaching, the larva stopped, raised the forward portion of its body, waved from side to side, and then moved toward the new position of the model. All larvae followed the model if it was moved, but some made gradual rather than abrupt turns toward its new position.

DISCUSSION

Our data and the data of Waldbauer & Sternburg (1967a) and Scarbrough et al. (1974) show that, generally speaking, overwintering

cecropia cocoons occur in two sorts of situations: 1) exposed to view on the branches of deciduous trees or shrubs, or 2) hidden near ground level among shoots or the stems of a shrub. The behavior involved in the selection of these sites is especially interesting because exposed cocoons are much more likely to be destroyed by woodpeckers than are hidden cocoons (Waldbauer & Sternburg, 1967b; Waldbauer et al., 1970).

The selection of the spinning site is significantly affected by the immediate environment of the feeding larva. Since feeding larvae are sedentary, we can assume that their location was ultimately determined by the ovipositing female. Larvae which feed on shrubs almost always spin the cocoon close to the ground on the same or an adjoining shrub. Larvae which feed in trees may spin on a branch of the tree, or they may leave and spin near ground level. They rarely return to a tree or climb another tree to spin unless other spinning sites are absent. In suburban, residential plantings, an average of 65%–71% of the larvae in trees ultimately left the tree to spin, either at its base or a more distant site.

The onset of site selection is obviously controlled by a circadian rhythm. The cocoon site is always selected in daylight. Larvae usually begin to wander in the morning and usually begin to spin before nightfall. If not, they rest during the night, and resume wandering the next morning. Wandering in daylight rather than at night probably increases the risk of predation, but has the advantage of allowing the larvae to use visual cues in selecting a spinning site.

Although we have not proved the point, our data suggest that the suitability of a potential cocoon site is determined by the larva's negative phototaxis and positive thigmotaxis. This tends to hide the cocoon. We suggest that the larva is led to the spinning site by positive geotaxis and, sometimes, by its ability to orient to objects visually. An endogenous factor lengthens the wandering phase, decreasing the probability that larvae in trees will spin cocoons before reaching the ground. This is adaptive because a cocoon that is hidden among the leaves of a tree in summer, will probably be exposed to view in winter.

The exposure of the larva to predation as it wanders in search of a spinning site seems to argue against the adaptive value of this behavior if one is not aware that most pupae in cocoons on trees are destroyed by woodpeckers during the winter (Waldbauer & Sternburg, 1967b; Waldbauer et al., 1970). The wandering phase lasts an average of 3.5 hours, but the larva is in the open for only a brief portion of this time. We do not doubt that this relatively brief exposure is more than offset by the advantage of spinning in a site where the cocoon is hidden from view during winter.

SUMMARY

The location of the overwintering cocoons of *Hyalophora cecropia* affects the probability that they will be attacked by vertebrate predators in winter. In this light we examined the selection of the cocoon site by the larvae, and the effect on this behavior of environmental factors in the suburban residential plantings in which cecropia is most common in central Illinois. Feeding larvae are sedentary and do not normally leave the host plants, shrubs and trees of many species. Between 3 and 9 hours ($\bar{x} = 5.7$) after sunrise, mature fifth instars spend a mean of 38 minutes emptying the gut, and then begin to wander. Wandering usually lasts from less than an hour to 8 hours ($\bar{x} = 3.5$), cocoon spinning beginning between 4 and 14 hours ($\bar{x} = 8.7$) after sunrise. On cool days the larvae may rest and resume wandering the next morning. The cocoon site is always selected in daylight. Larvae which feed in shrubs almost always spin close to the ground on the same or a contiguous shrub. Larvae which feed on trees may spin on one of its branches, where the cocoon is exposed to view in winter, or they may migrate to spin near ground level in shoots at the base of the tree or in a nearby shrub where they are likely to be hidden in winter. In suburban plantings between 65% and 71% of the larvae in trees spin near ground level. Larvae locate distant shrubs by their ability to orient to silhouettes from a distance. The larva is exposed to predation as it wanders from a tree, but this is offset by the advantage of spinning the cocoon where it will be hidden from woodpeckers in winter.

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ANTHRAEA POLYPHEMUS (SATURNIIDAE) AND BIBLIS HYPERIA (NYMPHALIDAE) IN TEXAS

The statement was made (Ferguson 1972, *Moths of North America*, Fasc. 20.2B, E. W. Classey Ltd., London, p. 200) that although *Antheraea polyphemus* (Cramer) is the most widely distributed of North American Saturniidae it has not been reported from counties of the southern coastal bend of Texas. On 18 September 1976, I took eight males of this species in black light traps at the Risken Ranch (27°9'N, 97°41'W) in Kenedy Co., definitely a southern coastal bend county. Three were kept as specimens, and one of the three was deposited in the U.S. National Museum. I had previously reported other, more northerly coastal bend records (Kleberg and San Patricio Co.) to J. F. Gates Clarke and at his suggestion sent voucher specimens to the National Museum.

Biblis hyperia (Cramer) (Nymphalidae) is reported by Howe (1975, *The butterflies of North America*, Doubleday, Garden City, NY, p. 125) to occasionally stray into the Brownsville region of Texas. In the Texas A & I University–Kingsville collection are three specimens (one female, two males) taken by members of my entomology class and myself at the R & B Welder Refuge near Sinton, San Patricio Co., Texas, on 30 November 1973. Some years previous to this date, Carroll Williams of the Corpus Christi (Texas) Museum mentioned to me that he had taken the species at the Welder Refuge. Good evidence exists that there is, or has been, a resident population of this species in the United States. Williams' specimens were taken at the "Hackberry Motte," mine ca. 6 mi distant at the "Bolsa," both areas of dense wood along the Aransas River.

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A NEW SUBSPECIES OF *PIERIS SISYMBRII* (PIERIDAE) FROM WESTERN GREAT PLAINS RELICT FORESTS

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Pieris sisymbrii Boisduval that occur in scarp woodlands on the western Great Plains have formerly been recognized as distinct from their Rocky Mountain counterparts (Johnson & Nixon, 1967; F. M. Brown, pers. comm.), but their extremely low density required several years for sufficient sampling. They represent a new, allopatric subspecies (described below)—part of a larger array of montane insects that occur northward from western Nebraska and originated in the vast conifer forests which once covered the area after the Wisconsin glaciation. They have been isolated in disjunct relict populations by drier climate and range fire. The present description is part of a larger study of speciation in this former montane area (Johnson, 1976, 1977; Johnson & Balogh, 1976).

Pieris sisymbrii nordini Johnson, new subspecies

Figs. 1, 2

Diagnosis. This subspecies can be distinguished from *P. s. elivata* Barnes & Benjamin by the following traits: Males, upper surface of the forewings: marking between veins Cu_1 and M_3 reduced or nearly absent; extreme proximity of veins R_1 and R_2 allowing only narrow costal margin, black coloration from dark bar at apex of discal cell extending costad and to base of wing (*P. s. elivata*: R_1 and R_2 broadly parallel, allowing wide costal margin, white ground color invading between it and the marking in the cell). Both sexes, undersurface of the hindwings: vein RS bending broadly along costal margin locating distal RS marking, mounted specimens, quite distad and below the tornus [*P. s. elivata*: RS highly arched, very limited in extension along costal margin (making distal RS marking, mounted specimens, appear well beneath inner margin of forewings)]. Male genitalia (Fig. 2): valvae longer and more broad, area between articulations broadly concave, caudal end exceeding tip of uncus, uncus more toothed than tapered [*P. s. elivata*: shorter, caudally tapered valvae, barely exceeding uncus; area between the articulation not smoothly concave, uncus gradually tapered; *P. s. sisymbrii*, *P. s. flavitincta* Comstock (Fig. 2)].

Male. Upper surface of wings: white; forewings with moderately dark subapical markings deeply incised between stem of veins $R_3 + 4/R_5$ and M_1 ; also less distinct marginal markings. Marking between veins Cu_1 and M_3 reduced or nearly absent. Dark coloration from marking, apex of discal cell, extending costad to base of wing. Hindwings above, vaguely dark along veins.

Undersurface of wings: forewing markings as on upper surface but more greenish with yellow-gold veins. Hindwings, veins outlined uniformly and thickly with brownish green, veins yellow gold; postmedian "arrowhead"-shape markings not concise, more bulbous than tapered; not extremely lightened patch basad along the veins.

Length of forewing: 19.0 mm (holotype), 17.0–19.0 mm (paratypes).

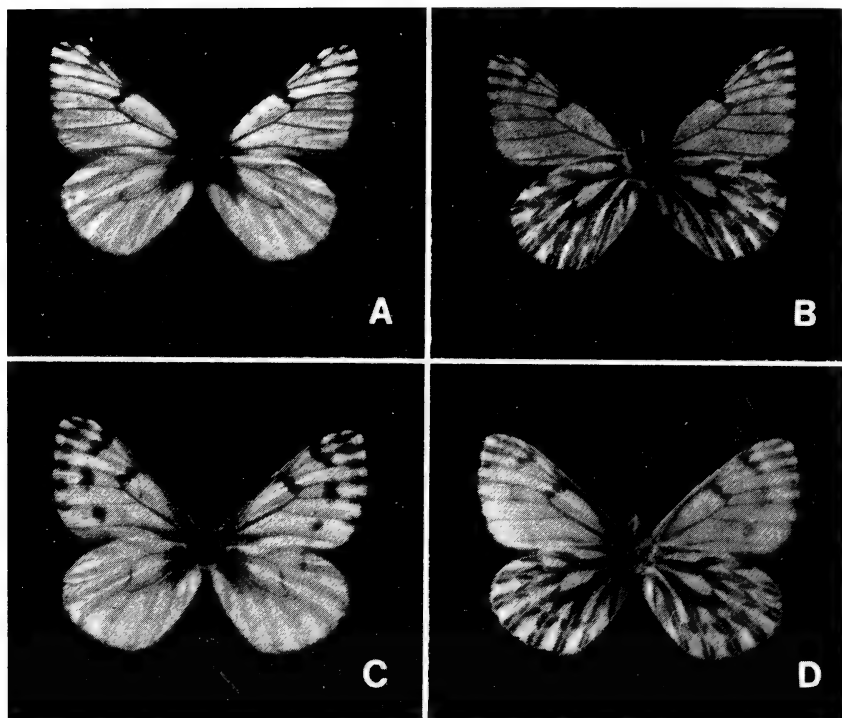


Fig. 1. *Pieris sisymbrii nordini*, new subspecies: (A) holotype, male, upper surface; (B) same, undersurface; (C) allotype, female (yellow), upper surface; (D) same, undersurface.

Female. Two morphs, white and yellow, the latter in high frequency [0.67 ($N = 6$)] compared with *P. s. elivata*, [0.22 ($N = 27$)].

Upper surface of wings: as in male, with marginal and apical-subapical markings darker and more extensive; postmedian marking between veins CU_1 and M_3 dark and extensive; also a dark marking between veins CU_2 and $2aA$. Hindwings heavily powdered along veins, especially above ventral postmedian "arrowhead" markings and at apex of cell.

Undersurface of wings: as in males, with dark postmedian markings between veins CU_1 and M_3 , and CU_2 and $2aA$.

Length of forewing: 19.0 mm (allotype), 17.0–19.5 mm (paratypes).

Male genitalia. Typical of the species, differing mainly as follows: valvae longer and more broad, caudal end exceeding length of uncus, area between articulations broadly concave; uncus caudally more toothed than gradually tapered.

Female genitalia. Typical of the species: sclerotized abdominal segments with apophyses; a large, toothed and bulbous-ended cylindrical signum in the wall of the oval-shape corpus bursae.

Early stages. Unknown.

Foodplant. Probably various Cruciferae (Brown et al., 1957; Ferris, 1971).

Types. Holotype, male, Monroe Canyon, Sioux Co., Nebraska, 24 May 1964 (K. Johnson), in the American Museum of Natural History (AMNH), genitalia in

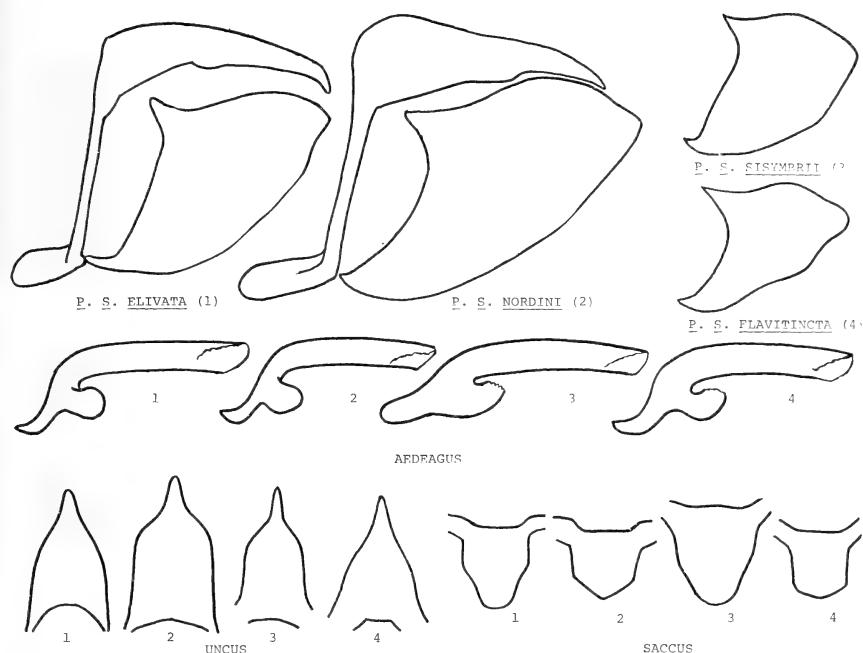


Fig. 2. Genitalia of Nearctic *Pieris sisymbrii* subspecies: (1) *P. s. elivata*, (2) *P. s. nordini*, (3) *P. s. sisymbrii*, (4) *P. s. flavitincta*. Upper: lateral view, uncus, vinculum, saccus, valva (valvae only, *sisymbrii*, *flavitincta*). Middle: lateral view, aedeagus. Lower: left, dorsal view, uncus; right, dorsal view, saccus.

vial KJ #2, same institution. Allotype, female, (representing morph of highest frequency, yellow), same locality, 24 May 1968 (K. Johnson), genitalia in vial KJ #19, same institution. Paratypes, males (battered): same locality, 20 May 1966 (K. Johnson), genitalia in vial KJ #17, same institution; same locality, 26 May 1937 (R. A. Leussler), genitalia in vial KJ #25, in collection of Ohio State University, Columbus, Ohio; Hell Canyon, S of Hwy. 16, Custer Co., South Dakota, 31 May 1968 (J. S. Nordin), in his collection: females (Y = yellow; W = white): (W), 5 mi. W of Pringle, Custer Co., South Dakota, 28 May 1966 (J. S. Nordin), in AMNH; (Y), Chadron, Dawes Co., Nebraska, 6 May 1962 (K. Johnson), genitalia in vial KJ #20, in the Los Angeles County Museum; (W), Monroe Canyon, Sioux Co., Nebraska, 24 May 1968 (K. Johnson), genitalia in vial KJ #18, in the Allyn Museum of Entomology; (Y), Cañon Region, N of Harrison, Sioux Co., Nebraska, 5 June 1914 (R. A. Leussler), genitalia in vial KJ #5, in collection of Ohio State University; (Y), Guffis Canyon Fire Road, Custer Co., South Dakota, 1 June 1968 (J. S. Nordin), in his collection.

Distribution. Black Hills of South Dakota and relict pine woodlands of Nebraska and perhaps North Dakota (Fig. 3).

Flight period. Mid-April (sight records, this author) to early June.

Remarks. These specimens were compared with 53 specimens of *P. s. elivata* from Wyoming and Colorado, of which 10 genitalia were studied. Specimens were

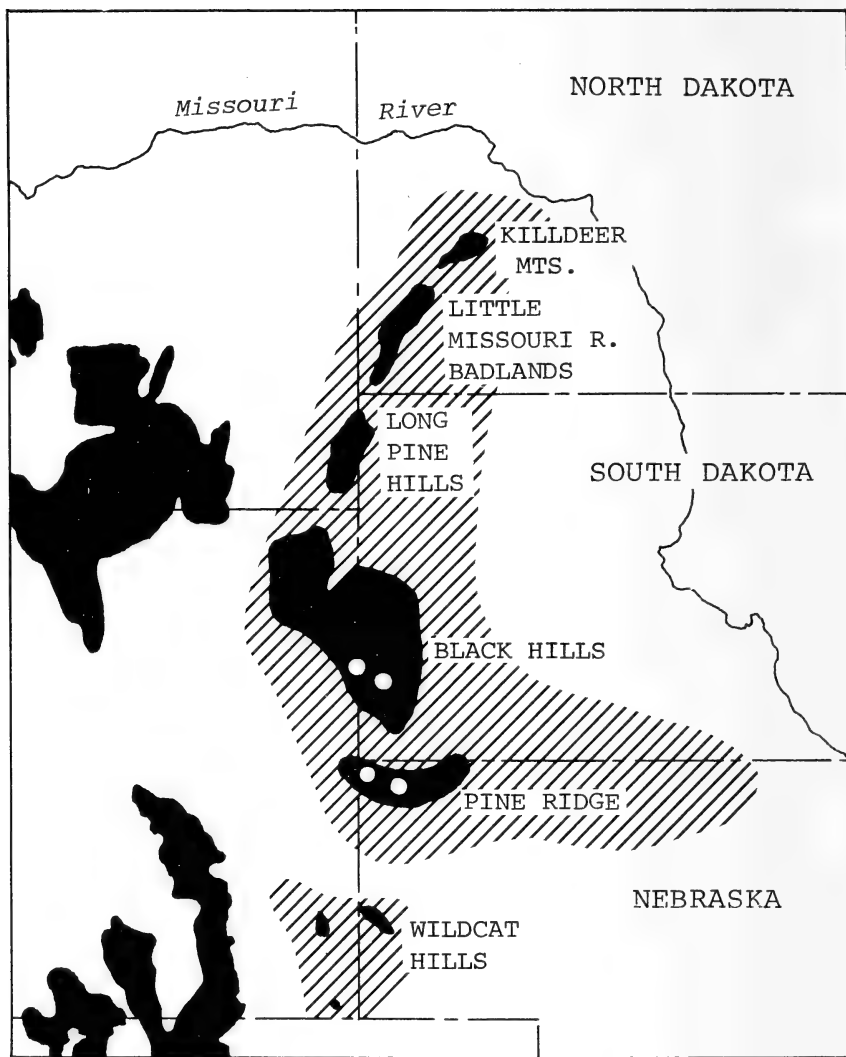


Fig. 3. Known distribution of *P. s. nordini*, new subspecies, superimposed on map of present-day montane area of eastern Rocky Mountains and western Great Plains (black areas). Hatching indicates approximate distribution of post-Pleistocene climax conifer forest. Open pine-juniper woodland extended around it, especially into central Nebraska and westward to the Rocky Mountain forests. Open woodlands, and then the forests, disappeared as conifer environments retreated upland leaving the present-day montane relicts.

also examined of *P. s. sisymbrii* from California and Utah, of which 6 genitalia were examined (3 ♂, 3 ♀).

Etymology. I am very pleased to name this subspecies after Dr. John S. Nordin (Warrington, Pennsylvania), whose collections and research concerning South Dakota butterflies comprise the largest single contribution to the knowledge of South Dakota's butterfly fauna in recent years.

DISCUSSION

Butterfly subspecies endemic to the relict woodlands of the western Great Plains usually are distributed disjunctly from the Wildcat Hills (Scotts Bluff and Banner Cos., Nebraska) and the canyons of Goshen Co., Wyoming [these being relicts of the former "Cheyenne Ridge" (Clements, 1949)] northward to the Pine Ridge of northwestern Nebraska, the Black Hills of South Dakota, and the scarps along the Little Missouri River in western North Dakota. Puckering & Post (1960) mention a "possible" *P. sisymbrii* from just below the North Dakota border in Harding Co., South Dakota. It is not specifically stated whether the specimen figured is the specimen from Harding Co.; the figured specimen does not match the description of *P. s. nordini* in major traits. This and the indistinctness of a marking between veins CU_2 and 2_{dA} (under-surface only), which if the specimen is a female should be much more distinct, suggest that their specimen may represent early spring *P. protodice occidentalis* Reakirt, as is also stated by Dr. A. B. Klots in Puckering & Post (1960).

ACKNOWLEDGMENTS

I am very grateful to Dr. John S. Nordin, Dr. Clifford D. Ferris (University of Wyoming, Laramie), Dr. C. A. Triplehorn (Ohio State University, Columbus), and John C. Downey (University of Northern Iowa, Cedar Falls) for loans of specimens or photographs and especially to Dr. Frederick H. Rindge, Curator of Lepidoptera, American Museum of Natural History, for providing facilities and advice during this study and editing the manuscript.

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OVIPOSITIONAL MISTAKE BY A HACKBERRY BUTTERFLY (NYMPHALIDAE)

Ovipositional mistakes by female butterflies have been previously reported (Remington, 1952, *Psyche* 59: 61-70; Dethier, 1959, *Can. Ent.* 91: 554-561; Neck, 1973, *J. Lepid. Soc.* 27: 22-33). Such mistakes may occur on toxic, exotic species which have palatable native congeners (Straatman, 1962, *J. Lepid. Soc.* 16: 99-103; Kendall, 1964, *J. Lepid. Soc.* 18: 129-157).

Herein is described the behavior of a single female *Asterocampa clyton texana* (Skinner) (Nymphalidae) which was observed at 1810 hrs. CST on 7 August 1970 in a residential area of Austin, Travis County, Texas. The adult was observed flying around the yard mostly at ground level. The individual landed momentarily on several ornamental plants: Chinese privet, *Ligustrum sinense* Lour. (Oleaceae); heavenly bamboo, *Nandina domestica* Thumb. (Berberidaceae) and corona vine, *Antigonon leptopus* Hook. & Arn. (Polygonaceae). Subsequently, it landed on a blade of St. Augustine grass, *Stenotaphrum secundatum* Kuntze (Gramineae), upon which it quickly laid three eggs. It then landed on several dead branches of an adjacent Texas sugarberry, *Celtis laevigata* Willd. (Ulmaceae), its major larval food-plant in central Texas. Extrusion of the ovipositor was observed several times but no oviposition occurred. After flying out of the immediate area, the same individual returned at 1825 CST. It landed on the trunk of the privet plant and extruded its ovipositor but laid no eggs. It then flew out of sight and was not seen again.

Asterocampa normally oviposits small to large egg masses on the underside of hackberry leaves (Comstock, 1953, *Bull. So. Cal. Acad. Sci.* 52: 127-136; Langlois & Langlois, 1964, *Ohio J. Sci.* 64: 1-11). These observations involved a female *A. clyton texana* which had mated and was apparently intensely stimulated to oviposit although unable to locate new-growth leaves of *C. laevigata*. Such leaves were non-existent at the time of observation; the last significant rainfall had occurred on 28 May (0.97 in.).

These observations may provide insight into future research possibilities on strategies of oviposition in *Asterocampa* in semi-arid habitats. Several days previous to time of observation, weather conditions were overcast with high humidity as a result of fringe weather associated with Hurricane Celia; barometric pressure was slightly below normal levels. No substantial precipitation was recorded (0.22 in. on 4 August). Prolonged periods of slightly depressed barometric pressure and elevated relative humidity would normally be a reliable predictor of sufficient rainfall to produce new growth on *Celtis* which provides requisite oviposition sites.

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STUDIES ON RESTINGA BUTTERFLIES. I.

LIFE CYCLE AND IMMATURE BIOLOGY OF *MENANDER FELSINA* (RIODINIDAE), A MYRMECOPHILOUS METALMARK

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This paper is the first of a series that deals with various aspects of the ecology of butterflies which inhabit the sandy coastal plains near the sea in southern Brazil. Called the "restinga" in Portuguese, it is an unique habitat that contains a large number of endemic plants and animals. Unfortunately, it is valuable land for real estate development and at present is being altered to make way for new residential and resort areas. Also, the new coastal highway from Rio de Janeiro to Santos, now under construction, is altering great expanses of restinga vegetation and in the process is opening up previously isolated areas to commercial exploitation. All this underlines the urgency with which the Brazilian coastal flora and fauna must be studied before their demise in the wake of "civilization."

The purpose of this paper is to describe the habitat and larval biology of *Menander felsina* (Hew.), an endemic restinga butterfly. The discussion will include descriptions of oviposition, larval behavior, and relationships with ants. A future paper will deal with other aspects of adult behavior and population dynamics.

Published information on the larval biology of the neotropical riodinids is very scanty, especially considering that there are over 1500 recognized species. The majority of references deal with foodplant records or a description of larvae and pupae (Zikán, 1920, 1953; Stichel, 1920; Beutelspacher, 1972; Monte, 1934; Raymundo, 1907; Santos, 1931; Gomes, 1940; Biezanko, 1949; Bertels, 1954; Mabilde, 1896; Ronna, 1933; Mariconi, 1961; Brandão, 1942). To date, I know of only four studies on the relationship of riodinid larvae with ants, these being Ross (1966), Guppy (1904), Bruch (1926), and Bourquin (1953), which cover a total of six species. In contrast, there are 245 known myrmecophilous lycaenid larvae (Downey, 1961). In the present paper, the riodinid list is increased to seven species, a number which I suspect will grow in time with additional observations.

The range of *M. felsina* is coastal Brazil from Joinville, Santa Catarina to Rio de Janeiro, the latter being the type locality (Hewitson, 1863). Seitz (1916) gives the distribution as being southern Brazil, and Staudinger (1888) mentions a specimen from Santa Catarina. The male

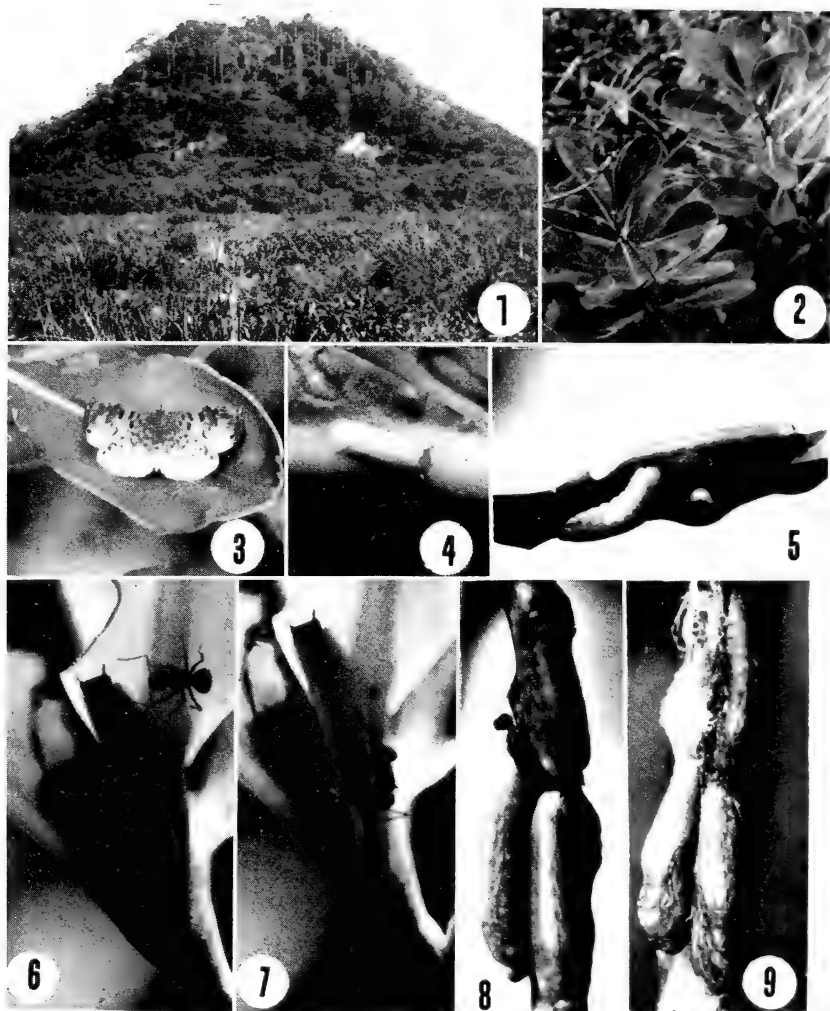
butterfly described by Butler (1877) is undoubtedly something else since it is nothing like those from southern Brazil. Certainly the confusion in this case resulted from Hewitson (1863–1878) illustrating only the female, leaving the male to the imagination. Material examined in the Museu Nacional and the Instituto Oswaldo Cruz collections indicates that the species is confined to the narrow coastal strip from Rio to Joinville, there being in addition to these localities specimens from Angra dos Reis between Rio and Santos.

Study Area and Methods

The study location is in a small woods at the base of a large rock (Fig. 1) some 20 m high called Pedra de Itauna at km 11 of the Rio-Santos highway. Here, the highway runs along a sand bar or "restinga" ca. 20 km long and 2 km wide that separates some small brackish water lakes from the open coast. An annual rainfall of ca. 1.5 m and an average temperature of 23°C place the area within the subtropical-humid classification of Holdridge (1967). The vegetation is not what one would expect in a subtropical-humid zone, however, since the sandy soils quickly drain moisture away, giving the landscape a rather desert-like appearance. The flats on the seaward side are covered with meter-high scrub that consists of bromeliads, cactus (*Cerus* sp.), and low deciduous bushes intermixed with grasses and other annuals such as *Sporobohas virginicus* and *Panicum racemesum* and with patches of low woods ca. 5 m high in protected localities. The vegetation in these latter areas is very dense, making penetration difficult except by man-made paths and in occasional sandy clearings, 5–10 m in diameter, which are encountered sporadically in the woods.

Typical genera of trees and bushes are *Myrsine*, *Ocotea*, *Myrcia*, *Tabebuia*, *Clusia*, *Eugenia*, and *Psidium*. The forest floor is packed knee deep in bromeliads, and the trees and bushes are festooned with mosses, lichens, and other epiphytic plants that take advantage of the frequent fogs which roll in from the sea. Bromeliads are represented by the genera *Nidularium*, *Billbergia*, *Aechmea*, *Vriesia*, and *Tillandsia*; Araceas by *Philodendron* and *Anthurium*; the Pteridophytes by *Lycopodium*, *Polypodium*, *Polystichum*, and *Elaphoglossum*; and the Gesneraceae by *Codonanthe* and *Hypocyrtia* among others (Joly, 1970). Gallery forests with trees up to 10 m high are found in the better protected parts on the leeward side of the restinga. These support a flora and fauna similar to those farther inland, with *Heliconia* plants and other shade-loving varieties replacing the bromeliads on the forest floor.

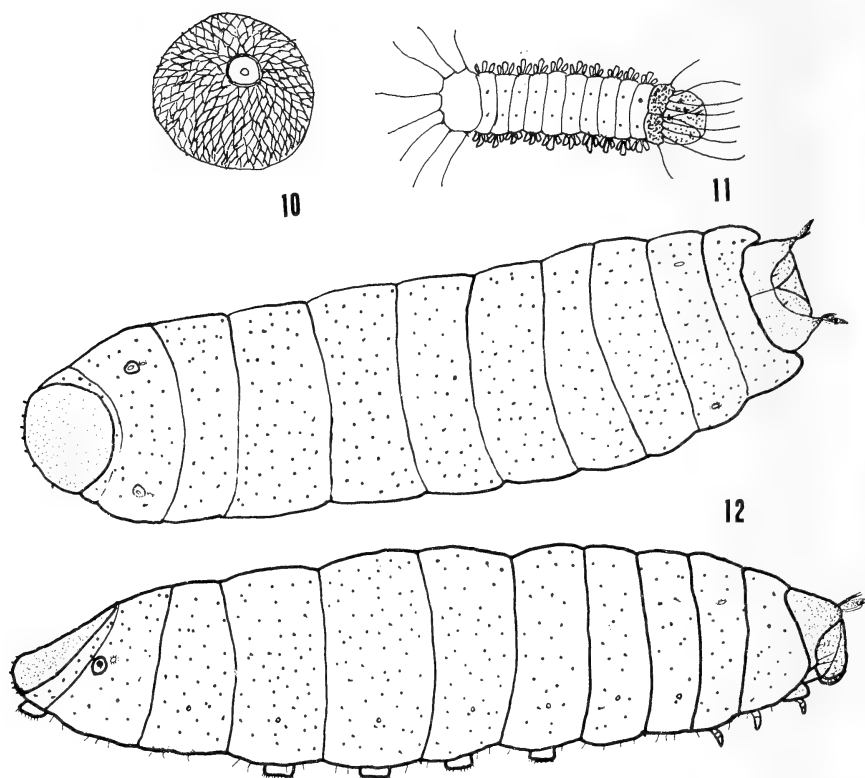
The habitat of *M. felsina* is the area of low woods just inside the seaward edge. Here, the adults can be found feeding on flowers and,



Figs. 1-9. 1, Habitat of *Menander felsina* showing woods at base of rock; 2, *Norantea brasiliensis*, foodplant of *M. felsina* larvae; 3, *M. felsina*, female on leaf of foodplant; 4, *M. felsina*, third instar larva; 5, *M. felsina*, fifth and sixth instar larvae; 6, ant (*Camponotus crassus* ssp.) "drumming" on larva of *M. felsina*; 7, ant (*Camponotus crassus* ssp.) feeding at honey glands of *M. felsina*; 8, *M. felsina*, prepupal larva, note honeydew on upper part of larva; 9, *M. felsina*, pupa.

in the case of males, patrolling along paths and in the sandy clearings. The *M. felsina* will fly outside the woods on the flats for oviposition and feeding.

The observations that form the basis of this study were made over a



Figs. 10-12. *Menander felsina*: 10, egg; 11, first instar larva; 12, final instar larva, side and top views.

period of four years and some 46 visits. Ova were obtained after observing ovipositing females in the field and immatures were acquired by rearing them from eggs or collecting them on the foodplant, *Norantea brasiliensis* Choisy (Marcgraviaceae) (Figs. 2, 3). These were brought into the lab with the foodplant and raised in fruit jars. Attempts to induce females to oviposit on foodplant in the lab were unsuccessful; the insects remained in the corner of the cage nearest the light until dying three or four days after being caged. Of the 10 larvae brought in from the field, six pupated and four emerged as adults. Causes of death for larvae appeared to be injuries due to handling. The reasons for the pupae not emerging are unknown. In no case, however, were parasites found on larvae or pupae. Of eight eggs collected, five hatched and two larvae were raised to the third instar. Some larvae died in the first instar because we had no foodplant for them.

Observations on ants were made both in the field and in the lab, and, in the latter case, on ants that were kept with the larvae.

Description of Immature Stages

Egg (Fig. 10). About 0.4 mm in diameter, flattened above and below, giving it the appearance of a rounded tire, covered with network of lines. Micropyle a small circle with a dot in the middle. Color brown, matching stem on which egg is laid. Duration: 10–11 days.

First instar larva (Fig. 11). Newly hatched larva 1.3 mm in length; light green in color except for head and prothorax, which are dark brown. Forward edge of prothorax with 10 long, flexible setae extending over head. Rest of thoracic and abdominal segments have scaly lateral protrusions, three to a segment, the middle one being the largest, and a double row of black spots on dorsum. A transparent carapace attached to anal segment and extending past the rear of the larva has six long, flexible setae along its edge similar to those on prothorax. Very small, inconspicuous spiracles located along sides of abdominal segments 1–8 and on suprapedal lobe of prothorax. Duration about 6 days; head capsule width 0.2 mm.

Second instar larva. Coloring as in first instar but with scattered green specks on body. Setae of the prothorax same as in first instar only with two having developed into flattened lobes reaching the length of head. The scaly lateral protrusions present but folded under body. Plate at end of abdomen has setae as in the first instar, though proportionally reduced in length. Spiracles as in first instar. Duration 4 days; total body length 3 mm; head capsule width 0.3 mm.

Third instar larva (Fig. 4). Coloring as in second instar. Head brown with white specks on face. Setae of prothorax reduced to two lobes with one long seta coming from base of each and with two shorter ones on the sides. Tail plate setae reduced to small projections, and protrusions on sides of body missing. Honey glands on eighth abdominal segment well-developed with spiracles immediately above them. Other spiracles as in first instar. A small slit found on upperside of metathorax, corresponding to the tubercles mentioned by Ross (1966). Duration 5 days; total body length 5 mm; head capsule width 0.5 mm.

Fourth instar larva. Color as in third instar. Setae of prothorax consist of two groups of three, flat, elongated lobes, one larger than the other two. Two large setae found on sides of prothorax. Legs bear tufts of setae, otherwise similar to third instar. Duration 4 days; total body length 7 mm; head capsule width 0.9 mm.

Fifth instar larva (Fig. 5). Similar to fourth instar. Duration 5 days; total body length ca. 16 mm; head capsule width 1.2 mm.

Sixth instar larva (Figs. 5, 12). Similar to fourth and fifth instars only larger. Four days after molting larva enters into prepupal stage, the body turning mottled brown, except for patch of original green color dorsally. Prepupa (Fig. 8) lasts for 5 days, after which the pupa is formed. Length of prepupal larva 22 mm; head capsule width 1.8 mm.

Pupa (Fig. 9). Light to dark brown mottled with greenish shading dorsally, attached by thin girdle passing over middle of body and by silk pad under last segment. Wing cases extend halfway along sides. Duration 22 days; total length 21.5 mm; width at widest part of body 5 mm.

DISCUSSION

The foodplant (*Norantea brasiliensis*) of *M. felsina* at the study location is woody with rounded succulent leaves growing alternately around stems that spread out in all directions from the base of the plant to a maximum height of 1.5 m. The flowers appear from late

September-January in the form of small red balls with nectar caps hanging below them growing off an extension of the stem. Individual plants are widely but sparingly distributed around the restinga, generally in the protection of clumps of larger bushes. All plants discovered in the study area showed signs of larval damage.

Oviposition occurs from 1230-1400. The female alights near the end of a stem of *N. brasiliensis* and walks down it in a spiraling motion exploring the surface with her abdomen. A single egg is quickly deposited on the main stem near the base of a leaf. She then flies a short distance away to rest on the upper surface of a leaf, wings outspread. Within two minutes she returns to the food plant, depositing another egg on a different stem of the same plant or on a second plant if there is one in the same vicinity. One female was observed placing four eggs within 12 min. A total of five ovipositions were observed, and in no case were more than four eggs deposited by any one female in any given session.

The tiny larvae hatch 10-11 days after oviposition and immediately move up to the leaf buds of the plant, where they begin to feed. They spend their time hidden inside the curled portion of the bud, betraying their presence only by the frass that they leave outside the opening. After the second molt they move out and start feeding on the older leaves as well as the buds, always eating the edges and ends of the leaves. Feeding is during the early morning, late afternoon, and evening hours and on cloudy days. During the hot part of the day the larvae move to cooler spots under leaves or near the stem of the plant and remain motionless, their flat profiles and green color allowing them to blend in perfectly with the leaves on which they rest. To determine whether they were active at night, two visits were made to the food-plant after dark. Using a flashlight with a piece of red plastic over the lens, two larvae were located resting on the plant. They showed no interest in feeding or any other activity during the 2 hours they were watched. This inactivity during the night was noted with larvae raised in the lab. However, molting, entering into the prepupal stage, and pupation all took place during the night in the lab. Larvae of about the same size will remain together for feeding and pupating. However, it was more common to find solitary larvae, one to a stem of foodplant. When larvae of different instars were raised together, they showed no interest in each other and always fed separately on different leaves. No cannibalism was observed. When moving onto a leaf the first time, they always laid down a trail that consisted of strands of silk with a weaving motion of the head. This trail was used to maintain a grip on the surface of the leaf. If knocked off, the larvae would invariably remain dangling by a thread of silk.

Starting with the third instar, the *M. felsina* larvae are myrmecophilous, being attended by ants that are a subspecies of *Camponotus crassus*. The early instars are completely ignored by ants. Upon encountering a larva, the ants will caress it with their antennae, rapidly alternating the strokes, first with one antenna and then the other, much as one would play a drum (Fig. 6). The larva responds to this "drumming" by extending two small glands located on the eighth abdominal segment from which is emitted a small quantity of clear liquid that the ants eat (Fig. 7). The ants remain in the vicinity of the larva for some time, returning now and then for more "drumming" and liquid. In the lab, I tickled a larva with a hair, ant fashion, and managed to get it to extend the glands. But these were quickly withdrawn and the larva started to move off, showing signs of being disturbed. Undoubtedly the larva was able to distinguish between ants and other stimuli.

In fact, an ant need not actually caress the larva; its mere presence nearby is enough to cause the larva to protrude the organs, an action that may serve as an attractor for the ants. The means by which the larvae know when an ant is near could not be determined during the study.

The honey glands located on the eighth abdominal segment were the only active myrmecophilous structures observed. On the metathorax are two slits high on the back corresponding to the lateral tubercles of Ross (1966), but prolonged observation of these under magnification failed to show any physiological change in them, even with ants in attendance. This is in contrast to the protrusion of the lateral tubercles noted in various other riodinid larvae such as *Lemonias rossi* (Ross, 1966) and *Audre* sp. (Callaghan, in prep.); these tubercles possibly serve to attract ants or frighten predators (Ross, 1966). Likewise, the "horns" of the prothorax in *M. felsina* appeared completely passive in relation to ants, unlike the vibrating pupilla of *L. rossi*. When disturbed, the *M. felsina* larvae nod the head rapidly up and down, creating vibrations inaudible to the human ear, but this seemed not to be directly related to the relationship with ants. The function of the "horn" structures in *M. felsina* remains a mystery, though, since ants were observed stroking the head and neck area, they could have an attractive or sensitive role.

The ants frequent the *N. brasiliensis* plants, eating plant secretions. When a larva is located, the discovering ant will communicate this information to nearby ants. An attendant ant was observed leaving a larva, walking over to another ant with whom it touched antennae, and being followed back to the larva, where both ants commenced "drumming" and partaking in the larva's fluids. Soon the first ant left, and the second

remained in attendance. Similar observations were made by Ross (1966), though in this case one ant passed honeydew to the other to communicate the presence of larvae.

It is apparent that the ants protect the larvae. In no case were larvae found parasitized by wasps, tachinid flies, or fungi, the constant attention of the ants undoubtedly serving to discourage this type of predation (Edwards, 1878). *Norantea brasiliensis* frequented by ants were largely free of other insect life, the exceptions being flying insects visiting the flowers and another lepidopterous larva found feeding on the leaves, but not attended by the ants. In contrast, other kinds of plants had numerous spiders and other small insects. To test the reaction of the ants to intruding organisms, small spiders were released on the *N. brasiliensis* near ants attending larvae. Upon discovering the intruders, the ants took up a defensive position, typical of *Camponotus*, by rearing up on the hind legs with the abdomen tucked between them. The intruders always beat a hasty retreat under these circumstances.

Observations of *M. felsina* indicate that the larvae remain on the foodplant 24 hours a day from hatching until pupal diapause, always with the ants nearby. The only time when larvae were discovered without ants was on one particular plant during a rainstorm.

Shortly after the fifth instar, the larva moves off the leaf where it had fed and crawls down the stem to the lower part of the plant. Here, it takes a head-down position on the stem or among the leaf litter nearby and assumes the mottled brown-green color of the prepupa. Observations of specimens in the lab indicate that this takes place at night. If disturbed, the larva will move off to find a more suitable spot. During this stage, the honey glands often secrete large quantities of honeydew, thus attracting the ants, which can always be found around the prepupal larvae. This undoubtedly provides protection during a very vulnerable period in the larva's life. After 5 days, the larval skin is shed and the chrysalid case hardens, again taking place during the night-time hours. The ants at this point lose interest and abandon the pupa. The imago emerges 21 days later.

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NOTES AND NEWS

Letters to the Editor

Dear Mr. Godfrey,

Referring to the article of Mr. Hans Epstein in "Notes and News" in the *Journal of the Lepidopterists' Society*, vol. 31, number 1, pp. 73-74, I have to protest strongly against Epstein's remark that "F. Bryk and C. Eisner . . . are heavily responsible for the oversplitting; for instance, by now 200 odd subspecies of Palaearctic *P. apollo* L. have been described." I regard it as a malicious remark. Objectively, many more *apollo* subspecies have been described by other authors than Bryk and myself.

Sincerely yours,
CURT EISNER

Dear Dr. Godfrey:

The repeated recent mentioning of *Papilio xuthus* occurring in Hawaii (vol. 30: 149 and vol. 31: 75) and the conjecturing about from where it may have immigrated needs a clarification from local Hawaiian records. The first specimen was recorded during April 1971 at Salt Lake, Honolulu, near Hickam Air Force Base. The species spread rapidly in the following years over all the Islands: 1972 Kauai, 1974 (June) Maui and Hawaii, 1974 (August) Molokai, 1974 (September) Lanai. Hawaiian entomologists are convinced that it came here by means of military planes, probably from Guam where it previously had its easternmost distributional limit. It is not alone in its way of immigration. Over the last few years we got also from Guam the banana skipper (*Erionota thrax*), the first specimen of which was caught at Hickam Air Force Base in August 1973. Three recent newcomers among the Sphingidae were also first recorded around Hickam Air Force Base. Their easternmost distributional limit before they came here was Okinawa: *Theretra nessus* (August 1974), *Deilephila nerii* (September 1974), *Macroglossum pyrrhostictum* (July 1976). Very often live specimens are intercepted by the quarantine service of the Department of Agriculture. So was recently recorded a ♀ of *Psilogramma menephron* on a military plane from the West Pacific (Guam?). Also commercial planes occasionally bring in interesting species: in a PAN AM plane from Pago Pago (Samoa) came a live ♂ of *Deilephila torenia*, a beautiful and rare, dark olive-green phenotype. One of the latest live interceptions on a military plane was a ♂ of *Hippotion boerhaviae* from Guam. Among the butterflies there suddenly appeared this year (January) large numbers of the gulf fritillary (*Agraulis vanillae*), and nobody has an explanation how that may have happened.

Sincerely,
J. C. E. RIOTTE

BIONOMIC NOTES ON SOME BAGWORM MOTHS
(PSYCHIDAE) OF TEXAS

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Jones & Parks (1928) listed 13 species of bagworms that were known to occur in the state of Texas with an additional three species whose presence was "anticipated." Four were later relegated to synonyms at the species level and two were apparent errors, leaving a total of seven species that actually had been definitely recorded from Texas (Davis, 1964). The first Texas record of one of the "anticipated" species has only recently been reported (Neck, 1976), bringing the total to eight.

The four synonyms followed by their present status are as follows: (1) *Thyridopteryx vernalis* Jones = *T. ephemeraeformis* (Haworth); (2) *Oiketicus bonniwelli* Barnes & Benjamin = *O. townsendi townsendi* Townsend; (3) *Oiketicus dendrokomos* Jones = *O. townsendi dendrokomos* Jones; and (4) *Platocoeticus jonesi* Barnes & Benjamin = *Cryptothela gloverii* (Packard). The first error is an "*Oiketicus* sp." which Jones & Parks (1928) state exists at high elevations in extreme western Texas and southeastern Arizona. Davis (1964) lists this form under "unidentified larval cases." He speculates that this may be an extreme northern extension of *Oiketicus kirbyi*, but his records are restricted to Arizona. The other species, *Prochalia pygmaea* Barnes & McDunnough, is more of a mystery. Jones & Parks (1928) state that it occurs from Bexar Co. (San Antonio) southward, whereas Davis (1964) records only a questionable identification at Dickinson (between Houston and Galveston) and states that the range is "much of the Atlantic and Gulf Coastal Plain from South Carolina to perhaps as far west as Texas." His westernmost confirmed locality is New Orleans.

Five species of bagworm moths are discussed below. *Thyridopteryx meadi* H. Edwards and *Oiketicus townsendi* Townsend (with two subspecies) are not discussed because of the author's unfamiliarity with these two species. No further discussion of *Oiketicus toumeyii* Jones is required because the few data accumulated for this species in Texas have been previously published (Neck, 1976).

Thyridopteryx ephemeraeformis (Haworth)

Thyridopteryx ephemeraeformis (Haworth), the evergreen bagworm, is quite common over most areas of the eastern United States, frequently becoming a local economic pest on various species of evergreens. Craighead (1950) reported that this species is known to flourish in Texas on

cedars (*Juniperus* spp.), willows (*Salix* spp.), and cypress (bald cypress, *Taxodium distichum* (L.) Rich.).

In early June 1969, the author received a collection of this species that had been feeding on Barbados cherry (Malphigiaceae: *Malphigia glabra* L.) although two specimens had switched to Japanese yew (Taxaceae: *Taxus cuspidata* Sieb. & Zucc.) and another two had switched to an ornamental holly (Aquifoliaceae: *Ilex* sp.). These latter two plants were located within several feet of the Barbados cherry. Unopened blossoms of the Barbados cherry were utilized in construction of the larval bags.

Bagworms are generally found on a large number of larval foodplants (see records in Davis, 1964) and change foodplants during their larval lifetime. Since this collection contained 52 individuals that had remained on Barbados cherry, a larval foodplant crossover experiment was devised. Rather than continuing to feed the larvae on Barbados cherry, they were fed pyracantha (Rosaceae: *Pyracantha coccinea* Roem.) for an initial 4-week period. For a second 4-week period, the larvae were switched to gum-elastic (Sapotaceae: *Bumelia lanuginosa* (Michx.) Pers.). At the end of the first four-week period a total of 17 live larvae and 11 pupae out of the original collection were still alive. A total of 24 larvae had died. By the end of the second phase of the experiment, all of the remaining larvae had died. Of the 11 pupae (10♂; one ♀), only four emerged (3♂; one ♀). Although individual bagworm larvae have been reported to switch foodplants (as indeed, four of the collection had switched), this particular pair of plants was found to be unacceptable to these larvae with few exceptions. No larvae were able to survive the second change of foodplant.

The single female emerged in mid-July with male emergence occurring in late July and early August. The female pupal case measured 27 mm in length. The mean pupal case length and mean larval bag length for males were, respectively, 17.7 (SE = 0.9; N = 3) and 40.7 mm (SE = 2.8; N = 3). The same two measures for the dead pupae (those which never emerged) were 15.9 (SE = 0.6; N = 7) and 42.9 mm (SE = 1.1; N = 7). Student's t-tests revealed that the difference between the respective means of the dead and emerged pupae was significant for pupal case length ($t = 2.7$; $p < 0.05$) but not for larval bag length ($t = 1.5$; $p > 0.1$). This difference in pupal length represents variations in the amount of leaf material consumed by the larvae. However, the fact that the larval bag length of the dead pupae was equal to (actually slightly longer than) that of the emerged pupae indicates that these dead pupae represented larvae which had shrunk below each individual larva's maximum size because of limited or total refusal to feed on the foodplant material provided in the laboratory. Emergence of an adult from a pupa is at least

partially dependent upon the amount and quality of resources ingested by a larva even though the ingestion level may well have been sufficient for pupation.

A further collection of *T. ephemeriformis* from Lubbock, Lubbock Co., was received in early October 1969. These individuals, which had been feeding on ornamental eastern red cedar (Cupressaceae: *Juniperus virginiana* L.), included two live male pupae, nine live female pupae, one empty female pupal case, two dead larvae, and two parasitized larvae. One male emerged on 15 October with five females emerging by 14 October. Parasites that had attacked one of the larvae had emerged through exit holes, leaving cocoons similar to those constructed by *Iphiaulax* (Hymenoptera: Ichneumonidae). Wasps in the other bag were preparing to pupate when received. The adult wasps, which emerged on 14 October, were identified as a hyperparasite, *Habrocytus thyridopterigis* How. (Pteromalidae), which has been reported from this bagworm species in West Virginia (Kulman, 1965). Judging from the size of the larval bag that contained these wasps, this hyperparasite attacks the parasites of rather young larvae. Dead specimens of *Spilochalcis* sp. (probably *mariae* (Riley)) have been found in larval cases of this species. The mean larval bag and pupal case length for males were 38.5 (SE = 1.5; N = 2) and 15 mm (SE = 1.0; N = 2), respectively. The same measures for females were 43.4 (SE = 1.1; N = 10). A t-test revealed significant differences between males and females for both larval bag length ($t = 4.1$; $p < 0.005$) and pupal case length ($t = 14.1$; $p < 0.001$) despite the small sample sizes involved.

Thyridopteryx ephemeriformis has been found on numerous host plants in the Austin area. A large, extinct colony was discovered on Oriental arbor vitae (Pinaceae: *Thuja orientalis* L.). Specimens have also been found on this plant in San Marcos, Hays Co. In Austin, isolated larval cases have been found on peach (Rosaceae: *Prunus persica* Batsch), cedar elm (Ulmaceae: *Ulmus crassifolia* Nutt.), plateau live oak (Fagaceae: *Quercus fusiformis* Small), turk's cap (Malvaceae: *Malva-viscus arboreus* Cav. var. *drummondii* (T. & G.) Schery), Texas persimmon (Ebenaceae: *Diospyros texana* Scheele), agarita (Berberidaceae: *Berberis trifoliolata* Moric.), pyracantha (Rosaceae: *Pyracantha coccinea* Roem.), willow baccharis (Compositae: *Baccharis salicina* T. & G.), Mexican plum (Rosaceae: *Prunus mexicana* Wats.); bald cypress (Taxodiaceae: *Taxodium distichum* (L.) Rich.), greenbrier (Liliaceae: *Smilax bona-nox* L.), ashe juniper (Cupressaceae: *Juniperus ashei* Buch.), Texas sugarberry (Ulmaceae: *Celtis laevigata* Willd.), slender bamboo (Gramineae: *Bambusa* sp.), and western soapberry (Sapindaceae: *Sapindus saponaria* L. var. *drummondii* (H. & A.) L. Benson). These

individual larvae apparently result from dispersal by first-instar larvae. These isolated larvae contained the two sexes in approximately equal numbers (eight ♂; six ♀).

In northeast Texas (Titus Co.), *T. ephemeraeformis* has been found feeding on the following plants: eastern red cedar (Cupressaceae: *Juniperus virginiana* L.), American elm (Ulmaceae: *Ulmus americana* L.), slippery elm (Ulmaceae: *Ulmus rubra* Muhl.), alder (Corylaceae: *Alnus serrulata* (Aiton) Willd.), and American hop hornbeam (Corylaceae: *Ostrya virginica* (Miller) K. Koch.).

Oiketicus abbotii (Grote)

Oiketicus abbotii (Grote) is restricted to the Atlantic and Gulf Coast from Virginia to Texas (Davis, 1964). Although the possibility exists that *O. abbotii* is part of a polytypic species, *O. kirbyi* Guilding, which would include the two above species and *O. townsendii*, Davis (1964) reports that the larval bags of these three taxa are quite distinct. The larval bags of *O. abbotii* and *T. ephemeraeformis* are of similar size but are easily distinguished by a single character. Twigs on larval bags of *O. abbotii* are placed transversely so that a cross section of the bag reveals an angular polygon. Twigs on larval bags of *T. ephemeraeformis* are placed longitudinally so that a cross section of the bag is roughly circular.

The author has found *O. abbotii* in Brownsville, Cameron Co., on a wide variety of host plants, e.g., tepeguaje or giant lead tree (Leguminosae: *Leucaena pulverulenta* (Schlect.) Benth.), mesquite (Leguminosae: *Prosopis glandulosa* Torr.), avocado (Lauraceae: *Persea americana* Mill.), Texas sugarberry (Ulmaceae: *Celtis laevigata* Willd.), Japanese honeysuckle (Caprifoliaceae: *Lonicera japonica* Thumb.), arbor vitae (Pinaceae: *Thuja orientalis* L.), and common rose (Rosaceae: *Rosa* sp.). The only infestation which could be called a colony was found on a single pyracantha bush (Rosaceae: *Pyracantha coccinea* Roem.).

Collection of larvae from the aforementioned pyracantha bush occurred in mid-July 1967. Larvae were quite active at this time but became relatively inactive in the latter part of July although increased activity became apparent in early August (all larvae observed in laboratory). Earliest adult emergence (♀) occurred on 30 August, but the next one (♀) did not emerge until 15 September. Final emergence (♂) occurred 4 October. Females tend to emerge earlier; five of the first six adults were female and the final three to emerge were males.

Of 33 larval cases collected in late June and early July at various localities in Brownsville, seven (21.1%) showed signs of parasitism. In late June, 10 adults of *Iphiaulax manteri* Nett. (Hymenoptera: Braconi-

dae) emerged from one of the bags. The cocoons of the wasps were present in two layers of five each, with the individual cocoons being parallel to the long axis of the bag. Stephens (1962) reported *Iphiaulax* sp. [near *I. sublucens* (Blanch.) + *I. diversus* (Vierick)] as attacking *O. kirbyi* in Costa Rica. Larvae of this form act as ectoparasites that gradually make their way to the center of the host.

In late July a mud wasp, *Pachodynerus astraeus* Cameron (Hymenoptera: Vespidae) emerged from one larval case. Examination of the interior of the case revealed two additional wasps. Each of the three cells were separated by a 2 mm thick layer of dried mud. The entire lining of the bag was covered by a layer of dried mud of 1 mm thickness. The bottom part of the bag was closed by a plug that was sculptured by the mother wasp. Davis (1964) reports a similar occurrence with bags of *O. toumeyi* being used by *Pachodynerus acuticarinatus* (Cameron). Whether the wasps utilize only empty bags or kill the inhabitant larva is unknown. Several additional bags of *O. abbotii* containing similar wasp cells from which adult wasps had previously emerged were collected.

Oiketicus abbotii also exhibits the common sexual dimorphism. Larval bag and pupal case mean lengths for males of the pyracantha colony were 50.5 (SE = 1.4; N = 6) and 18.7 mm (SE = 0.8; N = 6) respectively, whereas the two lengths for females were 61.0 (SE = 1.0; N = 5) and 25.2 mm (SE = 0.9; N = 5). The means are significantly different between the sexes for both larval bag length ($t = 8.1$; $p < 0.001$) and pupal case length ($t = 8.2$; $p < 0.001$).

Several additional infestations on pyracantha in Brownsville were discovered by or reported to the author. Explanation for this abundance on pyracantha at that time is unknown. Possibly this occurrence illustrated a temporary host race as discussed by Jones & Parks (1928). A return to these infestation sites in the summer of 1969 revealed no populations. If a host plant race had developed, its occurrence was temporary.

At localities other than Brownsville, only isolated foodplant records are available. One larval bag was found on southwestern bernardia (Euphorbiaceae: *Bernardia myricaefolia* (Scheele)) at Goliad State Park, Goliad Co. At Lake Corpus Christi State Park, San Patricio Co., larvae have been observed feeding on Texas persimmon (Ebenaceae: *Diospyros texana* Scheele), guayacan (Zygophyllaceae: *Porlieria angustifolia* (Engelm.) Gray), and little lead tree (Leguminosae: *Leucaena leucocephala* (Lam.) de Wit).

Cryptothelea gloverii (Packard)

Cryptothelea gloverii (Packard) occurs along the Atlantic and Gulf Coasts from South Carolina to Central America. The general form of the

larval case in this species is similar to that of *T. ephemeraeformis* but only one-half to one-third the length. In Austin, *C. gloverii* has been found infesting retama (Leguminosae: *Parkinsonia aculeata* L.), western soapberry (Sapindaceae: *Sapindus saponaria* L. var. *drummondii* (H. & A.) L. Benson), Texas sugarberry (Ulmaceae: *Celtis laevigata* Willd.), and common yarrow (Compositae: *Achillea millefolium* L.). In Brownsville, *C. gloverii* had been found on pyracantha (Rosaceae: *Pyracantha coccinea* Roem.) and lime prickly ash (Rutaceae: *Zanthoxylum fagara* (L.) Sarg.). The record on pyracantha was a fairly large colony on the same bush as the colony of *O. abbotii*. Small bits of leaves, bark and fruits were attached to the bags. The bags were found attached to almost all parts of the plant, e.g., trunk, stems, leaves, and even other bagworms. Larvae sought the security of the internal branches prior to pupation.

Collections were made during the first half of July, at which time the bags varied from 5 to 16 mm in length, with the majority being from 13–15 mm. Adult emergence occurred during mid-July with male pupal case length ($N = 5$) being very constant at 6–7 mm. Numerous mites were noticed on many of the bags. These mites have been predaceous on eggs as reported by Stephens (1962) for *O. kirbyi* in Costa Rica. On 12 July, the hatching of a total of 245 larvae from one larval case within ca. 3 hr was observed, with most of the hatching occurring within the first 2 hr. Behavioral patterns, i.e., orientation of abdomen and construction on initial larval bag, of the larvae were similar to those reported by Kaufman (1968) for *T. ephemeraeformis*.

A return trip was made in December 1969 to the Brownsville locality where *O. abbotii* and *C. gloverii* had been observed in the summer months of 1967. No trace of either species could be found. Food supply failure did not seem to be a logical reason for the local extermination because the pyracantha plant was in excellent condition and exhibited no evidence of previous extreme defoliation. Although there had been insecticide use to the east and southeast (directions of prevailing winds), drift is thought to have been minimal because ground-level hand spraying was employed. Three bird nests, probably constructed by mockingbirds, *Mimus polyglottus* (L.) (Passeriformes: Mimidae), a voracious insectivorous bird, were present in the bush. Stephens (1962) reported damage to a substantial number of bags of *O. kirbyi* which he attributed to an unknown bird species. Davis (1964) believes that some bird predation of bagworms (cases that exhibited holes) is the result of woodpeckers.

Overzealous collecting can be ruled out because bags in the top of the bush were not collected. These upper bags were not on the bush at the

time of the re-check. This fact raises the possibility that Hurricane Beulah, the eye of which passed within 20 mi of the area in September 1967, led to the decimation of this colony.

Astala confederata (Grote & Robinson)

Astala confederata (Grote & Robinson), the lawn bagworm, occurs in the eastern United States west to about the 100th meridian. Larvae have been found feeding on Texas spear grass, *Stipa leucotricha* Trin. & Rupr., and Johnson grass, *Sorghum halepense* (L.) Pers. (both Gramineae). The larval stage of this species is an inconspicuous ground-level feeder until it attaches to a tree trunk or building wall and thereupon pupates in April and May (Jones & Parks, 1928). A series of bags was collected at Austin in mid-May 1969. Most bags showed prior adult emergence, although one bag still contained a live larva. Adult emergence from those bags containing live pupae occurred for several days following collection, with several egg masses present in other bags hatching on 1 June. The adult male of *A. confederata* is somewhat larger than the previous species and much darker, being almost black.

Astala edwardsi (Heylands)

Astala edwardsi (Heylands), the chalk-hills bagworm, is restricted to Texas and Oklahoma (Davis, 1964), preferring barren areas where thin herbage only partially covers the limestone-derived soils. Jones & Parks (1928) report that the larvae eat both dead and living vegetable matter. I have observed one specimen feeding on thatch on the soil surface. The odd pencil-shaped bags are normally found on posts or tree trunks in September as the larvae ascend from the ground level. I have observed this species from the following localities in Texas: Crutchfield Ranch, Burnet Co.; 3 km S of Seguin, Guadalupe Co.; Austin, Travis Co.; and Longfellow, Pecos Co.

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BUTTERFLIES ASSOCIATED WITH AN ARMY ANT SWARM RAID IN HONDURAS: THE "FEEDING HYPOTHESIS" AS AN ALTERNATE EXPLANATION

Drummond (1976, J. Lepid. Soc. 30: 237-238) reported that a few female *Mechanitis isthmia* Bates (Nymphalidae: Ithomiinae) and male *Graphium philolaus* (Boisduval) (Papilionidae: Papilioninae) were attracted to a swarm raid of army ants (*Eciton burchelli* (Westwood)) in Honduras. As an explanation, Drummond suggested a "reproductive odor hypothesis" to account for the attraction of female *Mechanitis* to the swarm raid: the strong, unpleasant odor mimicked the courtship scent of male *Mechanitis*, thus causing females of this species to follow the swarm. As Drummond indicated, the attraction of male *Graphium* to the swarm raid was puzzling since, like ithomiines, males produce the courtship scent. Recent literature on the feeding behavior of selected butterflies suggests an alternative explanation to these interesting observations.

The acquisition of nutrients by adult butterflies of both sexes may be of widespread importance (Gilbert, 1972, Proc. Natl. Acad. Sci., U.S.A. 69: 1403-1407; 1976, Biotropica 8: 282-283; Arms et al., 1974, Science 185: 372-374). Adult butterflies are attracted to nutrient sites having an odor of decay (Gilbert, 1972, in litt.; Young, 1975a, Stud. Neotrop. Fauna 10: 19-56; 1975b, Rev. Biol. Trop. 23: 101-123; Young & Muyschondt, 1973, Carib. J. Sci. 13: 1-49). Ithomiine butterflies are attracted to fresh deposits of bird droppings splashed on leaves (pers. obs.). Drummond (in litt.) suggested that the male *Graphium* might be responding to an odor stimulus that elicits food searching behavior. These observations suggest that the attraction to nutrient sites by adult butterflies involves odors of decay, although this is only speculation at the present time.

Assuming that odors of decay cause the attraction of adult butterflies to nutrient sites, I suggest a "feeding hypothesis" as an alternative explanation for Drummond's findings: both the *Mechanitis* and *Graphium* butterflies were being "fooled" by the swarm raid odors. The odors of decay associated with the swarm raid triggered food searching behavior by these butterflies, causing them to follow the army ants. Such an explanation accounts for the attraction of both sexes to the ants. Under the feeding hypothesis, the attraction of butterflies to puddling sites, bird-droppings, manure heaps, etc. is aided by responses to characteristic odors associated with these sources of nutrients (amino acids, sodium, etc.).

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TWO NEW SPECIES OF CLEARWING MOTHS (SESIIDAE)
FROM EASTERN NORTH AMERICA CLARIFIED
BY SEX PHEROMONES

W. DONALD DUCKWORTH¹ AND THOMAS D. EICHLIN²

Recently, J. H. Tumlinson and colleagues (1974) and Yonce et al. (1974) identified chemical compounds from females of *Sanninoidea exitiosa* (Say) (peachtree borer) and *Synanthedon pictipes* (Grote & Robinson) (lesser peachtree borer), which may prove to be major components of the female sex pheromone systems of the Sesiidae as a whole. Males of the peachtree borer respond to a mixture containing mostly the Z,Z isomer of 3,13-octadecadien-1-ol acetate (Z,Z ODDA), while responses of the lesser peachtree borer males are inhibited by the presence of even small quantities of the above isomer (Karandinos et al., 1977). The E,Z isomer of ODDA is the major sex attractant for males of the lesser peachtree borer.

Since the initial isolation of the two pheromones, studies have been, and are continuing to be, conducted utilizing the geometric isomers of ODDA singly and in various combinations in traps in a variety of environments, mostly in Florida, Georgia, South Carolina, Ohio, Wisconsin, Washington and California. Cross attraction of different species to individual isomers or combinations has been demonstrated (Nielson & Balderston, 1973; Nielson et al., 1977; Karandinos et al., 1976). Most of the accumulated data on cross attractancy is still unpublished, but in summary, about 30% (42 species to date) of the known North American sesiid fauna north of Mexico, representing the full phylogenetic range of the family, have been captured in traps baited with the pheromones. In addition, a number of sesiid species have been captured using the pheromones in such widely differing areas as Mexico, Brazil, Costa Rica, Japan and Portugal (specific data as yet unpublished).

While the major impetus for research in sesiid pheromone identification and field screening has been the development of control measures for pest species, it is becoming increasingly apparent that a valuable new tool for improving our general understanding of sesiid biology and evolution has been discovered. There are significant gaps in our knowledge of sesiids, particularly in regard to distribution of species, relative abundance, seasonal periodicity, species diversity, etc., primarily due to

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the diurnal flight period and fugitive behavior of the adults, coupled with the endophagous boring habit of the larvae. Through the use of pheromones for field sampling of adult males it is now possible to more readily detect the presence of sesiids in a given habitat and greatly enhance the investigation of life cycles, behavior, and related phenomena.

In addition to the obvious benefits afforded by the use of sesiid sex pheromones for sampling purposes, it is important not to overlook the fundamental nature of pheromone systems in the evolution of the group. Clearwing moths are remarkably homogeneous structurally (Duckworth & Eichlin, 1974) and distinguishing closely related species is frequently difficult. Also, as our knowledge of distributions improves, many species previously thought to be allopatric are proving to be at least partially overlapping in their ranges. In instances where closely related species occur sympatrically, chemical compatibility may play a critical role in achieving reproductive isolation. For example, two very closely related sesiid species which attack *Viburnum*, *Synanthedon viburni* Engelhardt and *S. fatifera* Hodges, occur sympatrically in Wisconsin. Recent investigations (Karandinos, per. com.; Roelofs & Comeau, 1969) suggest that reproductive isolation is achieved, at least in part, by each species utilizing a different isomeric pheromone system. This phenomenon for isolation is probably also operative in areas of probable sympatry (i.e., Georgia and South Carolina) of *Synanthedon kathyae* n. sp. and the closely related species *S. alleri* (Engelhardt) which are discussed later in this paper. While it is overly simplistic to assume that pheromone systems alone have determined reproductive isolation in sesiid populations, it seems reasonable to assume that they are of increased importance in sympatric species where habitat preference, circadian and seasonal cycles, geographic distribution and other isolating mechanisms are less effective.

Biological studies on various sesiid species have been initiated as a result of information initially gained through field testing of sesiid sex pheromones. These studies are also contributing to our understanding of the systematics of sesiids. For example, Nielsen & Purrington (1975) present data on flight periods of *Podosesia syringae* (Harris) in Ohio which suggests the existence of a previously undescribed, sympatric species of *Podosesia* which is temporally isolated from *P. syringae* but virtually indistinguishable structurally. Similarly, pheromone studies in South Carolina by R. L. Holloway, Clemson University, have uncovered the presence of a previously unknown species and helped to clarify the status of another undescribed species, both of which are described in this paper.

As was the case in previous publications by the authors (Duckworth & Eichlin, 1973 and 1976), the following descriptions result from con-

tinuing revisionary studies on the Western Hemisphere Sesiidae and preparations for a fascicle on the Sesiidae for publication in *The Moths of America North of Mexico*.

We wish to acknowledge with our appreciation the following individuals and institutions who have provided specimens used in the present study: J. G. Franclemont, Cornell University, Ithaca, N.Y.; F. H. Rindge, American Museum of Natural History, New York, N.Y.; B. Wright, Nova Scotia Museum, Halifax; J. L. Sharp, Insect Attractants and Basic Biology Laboratory, USDA, ARS-Southern Region, Gainesville, Florida; C. E. Yonce, USDA, ARS-Southeastern Fruit and Tree Nut Research Station, Byron, Georgia; and R. L. Holloway, Clemson University, Clemson, South Carolina. For technical assistance we want to thank Laura S. Keller, University of California, Davis, for the drawings; Charles S. Papp, Scientific Illustrator, Special Services; and Magda R. Papp, Biological Technician, Laboratory Services, California Department of Food and Agriculture. For numerous beneficial suggestions on improving the manuscript we wish to thank R. C. Froeschner and W. D. Field, National Museum of Natural History, Smithsonian Institution, and J. A. Powell, University of California, Berkeley.

Genus *Synanthedon* Hübner

Synanthedon kathyae Duckworth & Eichlin, n. sp.

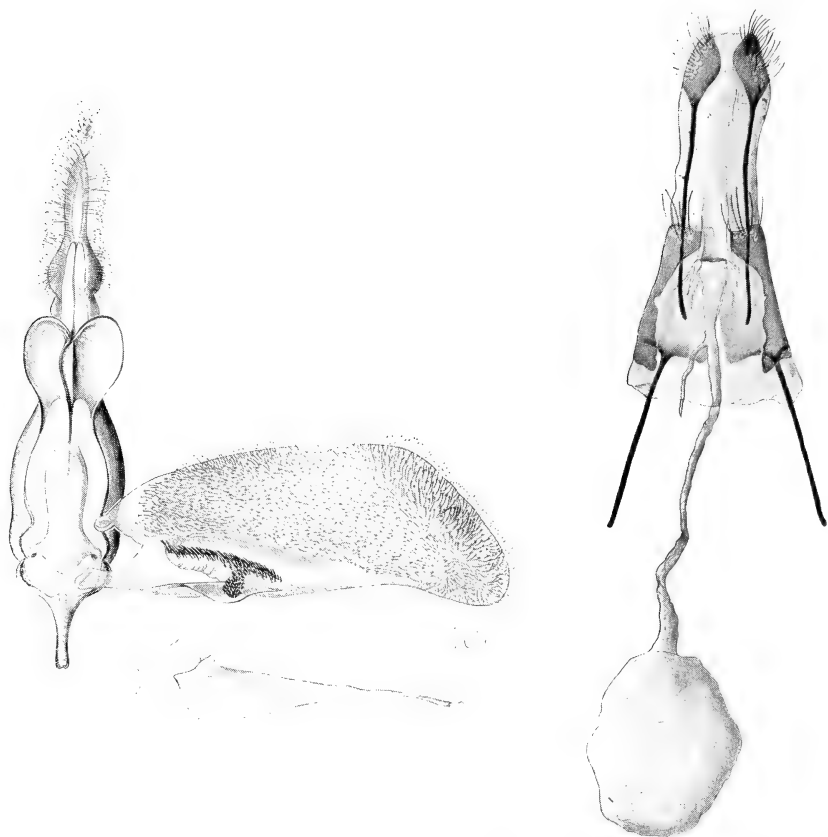
Male: Antenna blue-black, clavate, tufted with scales apically, ciliate ventrally. Proboscis well-developed. Labial palpus smooth, yellow. Head with vertex blue-black, front blue-black, white lateroventrally, occipital fringe yellow. Thorax blue-black, with subdorsal yellow stripes, and mostly yellow laterally beneath wings. Abdomen blue-black, dorsally with segments four and five yellow, ventrally yellow except segments two and three blue-black, anal tuft elongate, blue-black. Prothoracic leg mostly yellow, some blue-black often medially on coxa; mesothoracic leg blue-black, tarsi yellow; metathoracic leg with femur blue-black, tibia yellow with blue-black at base and on apical one-third, tarsi yellow. Forewing mostly hyaline, with very narrow margins, veins and discal spot blue-black, lightly powdered yellow on costal and anal margins dorsally, ventrally more strongly powdered yellow on margins and between veins apically. Hindwing hyaline, with narrow blue-black margins, costa yellow, fringe blue-black, becoming yellow at wing base. Male genitalia as in Fig. 1, typical of species placed in the genus *Thamnosphecia* (= *Synanthedon*) Spuler by Engelhardt (1946). Wing length of both sexes, 8–11 mm.

Female: Antenna as for male but lacking ventral cilia. Scale patterns like the male, with slightly broader apical margin on forewing and anal tuft brush-like. Female genitalia as in Fig. 2.

Host: Unknown.

Distribution: Halifax, Nova Scotia; Lewisboro, Westchester Co. and Long Island, New York; and near Oconee State Park, Oconee Co., South Carolina.

Types: Holotype: ♂, Halifax, Nova Scotia, summer 1965. J. A. Godbout, Genitalia Slide ♂, by T. D. Eichlin, USNM 76020, deposited in Nova Scotia Museum, Halifax. Paratypes 5: 1 ♀ with same data as holotype, Genitalia Slide ♀, by T. D. Eichlin, USNM 76036, in Nova Scotia Museum, Halifax; 1 ♀, Babylon, L.I., N.Y., 17.VII.37.



Figs. 1-2. Ventral view, genitalia of *Synanthedon kathyae*: (1, left) male (left valve removed); (2, right) female.

F. S. Blanton, Cornell University; 1 ♀, N.Y., Lewisboro, Westchester Co., 24-VII-1971, M. & T. M. Favreau, Genitalia Slide By M. R. Papp, CDA 225, in AMNH; 2 ♂, Oconee County, SC, ZZ ODDA Pheromone, Date: 25-VI-76, R. L. Holloway Coll., one specimen labeled, Genitalia Slide By M. R. Papp, CDA 221, in NMNH.

Discussion: On the basis of similar male genitalia, this species is closely related to *Thamnosphecia alleri* Engelhardt. The latter is known from Georgia, Florida, Alabama and Mississippi and differs from *Synanthedon kathyae* by having the forewings mostly opaque and the yellow markings replaced with orange.

R. L. Holloway captured two specimens of *S. kathyae* in South Carolina in traps baited with Z,Z ODDA. By contrast, both J. L. Sharp in Florida and C. E. Yonce in Georgia have been collecting *Thamnosphecia alleri* in nearly all months of the year (57 captures in 1975-76) using the E,Z isomer only.

Nothing is known of the biology of *kathyae* or *alleri*; Engelhardt (1946) believed the habitat of *alleri* to be open woodlands bordering on swamps.

This species is known only from the six specimens of the type series. It is named for Kathy Eichlin, who plays a continuing supportive role in all of the sesiid studies.

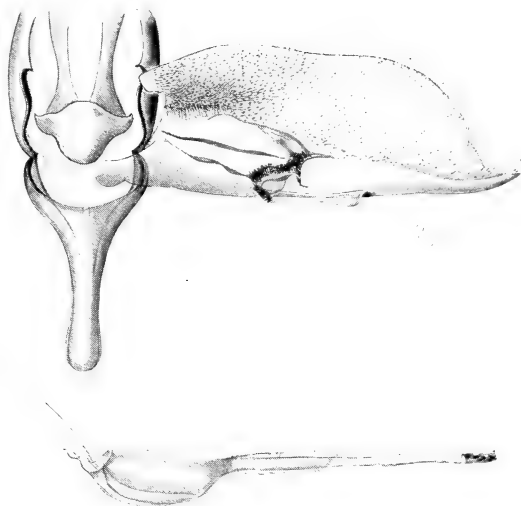


Fig. 3. Ventral view, male genitalia (left valve and tegumen-uncus complex removed) of *Carmenta odda*.

Genus *Carmenta* Edwards

Carmenta odda Duckworth & Eichlin, n. sp.

Male: Antenna clavate, tufted with scales apically, ciliate ventrally, brown-black and with yellow dorsally. Proboscis well-developed. Labial palpus yellow dorsally. Head with vertex brown-black, mixed with yellow anteriorly, front rubbed on type, probably brown-black with white laterally, occipital fringe yellow, rubbed dorsally. Thorax brown-black, yellow subdorsal stripes, yellow beneath wings and on metathorax dorsally. Abdomen brown-black, dorsally with all segments narrowly banded posteriorly with yellow except third, fourth with widest band, ventrally with segments one and two solid pale yellow, four banded yellow, others with some yellow on posterior margin, anal tuft rubbed off. Legs missing from this specimen except forecoxae which are brown-black with yellow on lateral one-half. Forewing mostly hyaline but opaque costal margin spreading apically to cover area to below M_1 at wing margin, basal one-half with wing powdered orange on veins and margins, outer one-half of discal spot yellow-orange, yellow-orange more extensive ventrally but apparently not powdered in apical area. Hindwing hyaline, very narrow margins, some yellow powdering on costa. Male genitalia as in Fig. 3. Wing length, 9 mm.

Host: Unknown.

Distribution: Trenton, Edgefield Co., South Carolina.

Holotype: ♂, Edgefield Co., SC., VI-11-1975, Coll. R. L. Holloway, ZZ pheromone, Genitalia Slide By T. D. Eichlin, CDA 179, (U.S.N.M. No. 73592); in NMNH.

Discussion: This species is described from a male specimen taken in a pheromone trap coated with a sticky adhesive which resulted in the poor condition. However, this capture represents the first new species in the U.S. to be discovered by the use of the sesiid pheromone, Z,Z 3,13-octadecadien-1-ol acetate and is named after this useful survey tool.

Carmenta odda superficially resembles *Ramosia arizonae* (Beutenmüller), *Synanthedon arkansasensis* Duckworth & Eichlin, and *S. refulgens* (Edwards) (see Duck-

worth & Eichlin, 1973; Engelhardt, 1946), but the structure of the saccular ridge on the valva of *C. odda* is unlike any known species of Sesiidae in North America.

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GENERAL NOTES

CATOCALA (NOCTUIDAE) SPECIES TAKEN IN CLAY COUNTY,
TENNESSEE

While collecting Lepidoptera in southwestern Michigan and on seven collecting trips of one or two annually to Clay Co., Tennessee from 1970–1976, I became aware of the large *Catocala* fauna of the latter area as compared to Michigan where many of the same species are rare or absent. Subsequently I made a special effort to collect this genus in Tennessee during 1975–1976. The majority of records listed below were made during this period.

MATERIALS AND METHODS

Collecting was conducted from 20 June–22 August within a two-mile radius of Celina in north-central Tennessee. The general countryside, being a part of the Cumberland Mountains, is hilly and heavily forested. Common trees here include White and Black Oak (*Quercus alba* L. & *Q. ellipsoidalis* Hill), Mockernut and Shagbark Hickory (*Carya tomentosa* Nutt. & *C. ovata* Mill.), Honey Locust (*Gleditsia triacanthos* L.), Black Walnut (*Juglans nigra* L.), American Beech (*Fagus grandifolia* Ehrhart), Tulip Poplar (*Liriodendron tulipifera* L.), Black Maple (*Acer nigrum* F. Michaux), and White Ash (*Fraxinus americana* L.). The forested collecting areas generally consisted of about 25% hickory, 35% oak, 20% beech and maple, and 20% miscellaneous species. Most night collecting was done during a new moon phase with night temperatures averaging 60°–70°F.

Four basic collecting methods were used for collecting *Catocala*: bait, ultraviolet and mercury vapor light, tapping trees, and a 150-watt incandescent light. Baiting was done along a path in an oak-hickory woods. The bait, consisting of beer, sugar, molasses, and fermented fruit, was applied to about 40 trees at dusk and checked periodically until about 0200 hours. A single 15-watt unfiltered fluorescent black-light tube set up in front of a sheet hung alongside the place of residence and a 150-watt incandescent porch light were checked at regular intervals throughout every night. In 1976 a 175-watt mercury vapor lamp was used along with the other light sources. Tapping trees with a wood mop handle to flush resting moths during the daytime was done primarily in the same oak-hickory woods that baiting was done. Data was recorded in a field notebook as soon as possible on species behavior and numbers.

The *Catocala* species and forms were determined by referring to the works of Barnes & McDunnough (1918, Mem. Amer. Mus. Nat. Hist. 3(1), 47 p., 21 pl.) and Sargent (1976, Legion of night. Univ. Mass. Press, Amherst, 215 p., 8 pl.), as well as examining *Catocala* collections of M. C. Nielsen and Michigan State University at East Lansing. The lone *C. gracilis* specimen, although worn, was determined by the presence of the short basal forewing dash often used in separating *gracilis* from the very similar *C. sordida*.

All specimens collected have been deposited in my personal collection in Kalamazoo, Michigan, given to Mike Larkin also of Kalamazoo, or donated to Western Michigan University.

RESULTS AND DISCUSSION

As of August 1976 the *Catocala* species total for Clay Co., Tennessee is 41. A list of the species arranged according to McDunnough (1938, Mem. So. Calif. Acad. Sci., Vol. 1. 275 p.) that includes earliest and latest dates taken and other capture data is shown in Table 1. The dates given in Table 1 coincide only with my collecting trips and should not be construed as conclusive. Many of the species have longer flight periods than shown. However, species whose condition and or numbers that

TABLE 1. *Catocala* collected in Clay Co., Tennessee at bait (B), ultraviolet and mercury vapor lights (UV & MV), tapping trees (T), and 150-watt incandescent light (IN). Tree species tapped are Shagbark Hickory (SH), Mockernut Hickory (MH), Black Oak (BO), White Oak (WO), and Black Maple (BM).

Species	Earliest & latest collecting dates	Method of capture				Tapping results Tree species						Total number of specimens
		B	UV & MV		T	IN	SH	MH	BO	WO	BM	
<i>C. innubens</i> Gn. incl. "scintillans" G. & R.	4 July-7 Aug.	13	9	10	-	-	1	4	3	-	2	32
<i>C. piatrix</i> Grt.	5 July-5 Aug.	5	1	-	-	-	-	-	-	-	-	6
<i>C. epione</i> Dru.	21 June-6 Aug.	9	31	2	2	2	1	1	-	-	-	44
<i>C. habilis</i> Grt.	31 July-6 Aug.	-	2	13	-	-	12	-	-	1	-	15
<i>C. serena</i> Edw.	11 July-6 Aug.	-	4	5	-	-	5	-	-	-	-	9
<i>C. robinsoni</i> Grt.	6 Aug.	-	-	1	-	-	1	-	-	-	-	1
<i>C. Judith</i> Stkr.	25 June-6 Aug.	1	8	15	-	-	15	-	-	-	-	24
<i>C. flebilis</i> Grt.	5 July-6 Aug.	9	8	22	-	-	5	14	2	-	1	39
<i>C. angusi</i> Grt. incl. "lucetta" Hy. Edw.	31 July-6 Aug.	6	4	12	-	-	12	-	-	-	-	22
<i>C. obscura</i> Stkr.	4 July-6 Aug.	45	3	28	-	-	25	2	1	-	-	76
<i>C. residua</i> Grt.	4 July-6 Aug.	42	1	7	-	-	7	-	-	-	-	50
<i>C. sappho</i> Stkr.	4 Aug.-6 Aug.	-	2	1	-	-	1	-	-	-	-	3
<i>C. relecta</i> Grt. incl. subspecies												
<i>luctuosa</i> Hlst.	5 July-6 Aug.	36	6	21	-	-	14	1	-	6	-	63
<i>C. ulalume</i> Stkr.	31 July-4 Aug.	-	1	1	-	-	-	-	-	-	1	2
<i>C. dejecta</i> Stkr.	24 June-4 Aug.	3	16	4	-	-	4	-	-	-	-	23
<i>C. insolabilis</i> Gn.	4 July-3 Aug.	6	5	5	-	-	5	-	-	-	-	16
<i>C. vidua</i> A. & S.	1 Aug.-6 Aug.	16	-	12	-	-	7	-	-	5	-	28
<i>C. maestosa</i> Hlst.	2 Aug.-3 Aug.	-	-	2	-	-	-	-	-	2	-	2
<i>C. lacrymosa</i> Gn. incl. "evelina" Fr. & "zelica" Fr.	16 July-5 Aug.	8	2	5	-	-	1	-	3	-	1	15

TABLE 1. (Continued)

Species	Earliest & latest collecting dates	Method of capture				Tapping results Tree species					Total number of specimens
		B	UV & MV	T	IN	SH	MH	BO	WO	BM	
<i>C. palaeogama</i> Gn. incl. "phalanga" Grt. & "amida" Fager	5 July-6 Aug.	5	9	10	-	2	2	3	-	3	24
<i>C. nebulosa</i> Edw.	5 July-6 Aug.	3	6	2	-	-	-	2	-	-	11
<i>C. subnata</i> Edw.	5 July-5 Aug.	1	5	4	-	2	-	-	2	-	10
<i>C. neogama</i> A. & S.	5 July-6 Aug.	10	9	5	-	5	-	-	-	-	24
<i>C. illa</i> Cram.											
incl. "conspicua" Worth.	20 June-6 Aug.	128	47	3	1	-	-	3	-	-	179
<i>C. cerogama</i> Gn.	4 July-6 Aug.	11	-	-	-	-	-	-	-	-	11
<i>C. relicta</i> Wlk.	22 Aug.	-	1	-	-	-	-	-	-	-	1
<i>C. cara</i> Gn. incl. subspecies											
<i>carrisima</i> Hlst.	2 Aug.-6 Aug.	7	-	-	-	-	-	-	-	-	7
<i>C. amatrix</i> Hbn.	4 Aug.	1	-	-	-	-	-	-	-	-	1
<i>C. illecta</i> Wlk.	24 June-28 June	-	8	-	-	-	-	-	-	-	8
<i>C. gracilis</i> Edw.	12 July	-	-	-	1	-	-	-	-	-	1
<i>C. andromedae</i> Gn.	23 June-15 July	-	16	1	1	1	-	-	-	-	18
<i>C. coccinata</i> Grt.	23 June-27 June	-	7	-	-	-	-	-	-	-	7
<i>C. miranda</i> Hy. Edw.	26 June	-	1	-	-	-	-	-	-	-	1
<i>C. ultronia</i> Hbn. incl. "celia" Hy. Edw.	23 June-3 Aug.	10	18	2	1	2	-	-	-	-	31
<i>C. grynea</i> Cram.	23 June-17 July	-	4	-	-	-	-	-	-	-	4
<i>C. clintoni</i> Grt.	23 June-28 June	1	2	-	-	-	-	-	-	-	3
<i>C. similis</i> Edw.	26 June	-	1	-	-	-	-	-	-	-	1
<i>C. minuta</i> Edw. incl. "mellitula" Hlst.	23 June-27 June	-	5	-	1	-	-	-	-	-	6
<i>C. micronympha</i> Gn. incl. "hero" Hy. Edw. & "gisela" Meyer	22 June-16 July	2	38	5	2	-	-	1	4	-	47

TABLE 1. (Continued)

Species	Earliest & latest collecting dates	Method of capture				Tapping results Tree species					Total number of specimens
		B	UV & MV	T	IN	SH	MH	BO	WO	BM	
<i>C. connubialis</i> Gn. incl. " <i>cordelia</i> " Hy. Edw.	23 June-27 June	-	5	-	1	-	-	-	-	-	6
<i>C. amica</i> Hbn. incl. " <i>curvifascia</i> " Brow.	26 June-2 Aug.	-	9	23	-	-	1	10	12	-	32
Total number of specimens	20 June-22 Aug.	378	294	221	10	129	25	27	32	8	903
Numbers broken to percentages (%)		42	33	24	1	58	11	12	15	4	

appeared to be affected by the restrictive collecting dates are subsequently discussed. Although additional coverage of Clay Co. will undoubtedly add more species and behavior data, certain interesting conclusions can be drawn from Table 1.

The 5 July collecting date for *C. piatrix* is very early for Tennessee, as this species peak flight is normally early to mid August. This could account for the small number taken of a fairly common species. The *C. robinsoni* male taken on 6 August is likewise a very early date for the species. I have seen fresh *robinsoni* in the M. C. Nielsen Collection from Missouri with mid-September dates. The 2 males of *C. sappho*, and to a lesser extent a female, captured in early August were very worn, suggesting a mid-July flight period in Tennessee. Specimens of *C. ulalume* and *C. maestosa* were fresh, indicating their capture dates probably fall within the species main flight period. The late June dates recorded for *C. clintoni* are quite advanced. All specimens were worn and this species is generally considered to be the earliest *Catocala* on the wing. Eggs were secured from one female. The flight period of the smaller species begins about 20 June in Tennessee as nearly all specimens taken at that time were fresh. In cases where the small number of species taken prohibited an accurate determination of the flight period, Forbes (1954, Cornell Univ. Agric. Expt. Stat., Mem. 329. 433p.), Sargent (1976), and various *Catocala* collections were consulted to arrive at more accurate flight times.

More specimens were taken at bait than by other methods because of large numbers of a few species, e.g., *C. obscura*, *residua*, *resecta*, *vidua*, *cerogama*, *illia*, and *cara*. These same species are also found commonly at bait in Michigan. Baiting success was greatest right after dusk and became progressively worse into the night. *C. angusi* was the only species recorded as a consistent late night feeder, never appearing till a few hours after dusk. Dry, warm, still nights were more productive than heavy, humid nights, such as after a rain. I believe high humidity may dilute the scent of the bait. Moon phase did not appear as a factor in baiting success.

Light attracted a wider variety of species than any other method with small *Catocala* being especially susceptible. The most productive night of collecting at bait and light occurred when a distant electrical storm was brewing.

Shagbark Hickory produced more *Catocala* than all other species of trees tapped. Hickories composed only about 25% of the total tree species, but yielded 70% of the underwings. Tapping was best during hot, dry afternoons. If any electrical discharge was in the air, such as an oncoming storm, the results were phenomenal. I have scared as many as 10-12 moths off Shagbarks about 0.67 m in diameter. During cool days, moths might rest higher in trees using more exposed positions for thermoregulation, which could account for the very poor results during those times. I have flushed *Catocala* from under shale outcroppings in woods. I could not make any positive identifications, but the species (about 5) were all large with yellow hindwings, perhaps being *C. nebulosa*. This species is reported to select unusual resting places (Sargent, 1976).

In addition to the results recorded in Table 1, other interesting *Catocala* observations were made. *C. obscura* and *residua* intergrade very closely in Clay Co. The two species ranged from very distinct to almost totally indistinguishable. This observation for this area agrees with that made by Sargent (1976). *C. obscura* alone exhibits much individual variation. Some specimens are large (70 mm), with greenish tinged, dark, well maculated forewings that are marked with a black dash extending from slightly below the apex to the outermost point of the pm line. Specimens at the other extreme are small (62 mm) with light, uniform dusky brown primaries that have very little maculation. These variations, with little blending, are found in both sexes. All *C. obscura* from Michigan are of the latter description. Clay Co. lies within the range of *C. resecta luctuosa*, and appears to be a blend zone with many intergrades between the nominate form and the subspecies taken here. Both nominate *C. cara* and *C. c. carissima* were very distinct with no intergradation. I found this interesting, but because of the small sample size, I hesitate to speculate

further on this observation. The single specimen of the typical *C. relict*a was a positively identified sight record. Sargent (1976) mentions Kentucky as the southern limit of this species, however Mather (pers. comm.) informed me of a single record from Mississippi. All *C. illect*a (males) were captured between 0300 and 0400 hours and could suggest that this is an active late night species. The lone capture of *C. miranda* was made at 0400 hours. This species' rarity might be due in part to its being a late flyer. Sargent (1976) gives some Atlantic Coast states, with Pennsylvania, as the range of *C. miranda*, but besides this specimen, I have found another one from Tennessee in the Michigan State University collection at East Lansing, Michigan.

The only regional list of *Catocala* I could find for any area close to Clay Co. was from Mather (pers. comm.) for Mississippi. Mather did not include *habilis*, *judith*, *flebilis*, *subnata*, *cerogama*, *miranda*, or *coccinata*. Species with only one or two records include *serena*, *obscura*, *residua*, *sappho*, *palaeogama*, *relict*a, *gracilis*, *clintoni*, and *minuta*. According to the *Catocala* ranges given by Sargent (1976) and assessment of local foodplants, the following might be expected to occur in Clay Co., but have not been recorded: *C. consors* A. & S., *agrippina* Stkr., *marmorata* Edw., *junctura* Wlk., *sordida* Grt., *crataegi* Saund., *mira* Grt., *titania* Dodge, and *dulciola* Grt.

The diversity of *Catocala* species encountered in Clay Co. is remarkable for only two years of fairly concentrated collecting. I would greatly appreciate hearing from anyone who has collected this genus in the Tennessee or Kentucky area.

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APPARENT LONG-DISTANCE DISPERSAL BY *PIERIS OCCIDENTALIS* (PIERIDAE)

Colonizing ability and the turnover rate of local populations of animals depend to a considerable degree on vagility. Records of "stray" butterflies are common in the literature, although it is rarely possible to deduce the manner of dispersal or even a minimum distance traveled. Altitudinal displacements sometimes offer good opportunities of this sort (Shapiro, 1973, J. Res. Lep. 12: 231-235; 1974, Ibid. 13: 157-161). The western white (*Pieris occidentalis* Reakirt) and the checkered white (*P. protodice* Boisduval & LeConte) are a pair of sibling species which generally replace each other, occurring at high and low altitudes respectively through most of western North America. Both are believed to be colonizing species, with vigorously dispersing adults (Shapiro, 1975, Amer. Midl. Nat. 93: 424-433). *P. protodice* seems unable to overwinter in Donner Pass (Placer/Nevada cos., California) at 7000 feet, but regularly colonizes the area in summer. Records of downslope dispersal by *P. occidentalis*, which is not known to breed in the Sierra below 6000 feet, are much rarer. On 13 August 1975 a worn female was taken at 5000 feet in the South Yuba River Canyon, Nevada Co., and I considered this a noteworthy "low elevation" record for California (Shapiro, unpublished).

On 17 October 1976 I was collecting a sample of *P. protodice* at Rancho Cordova, Sacramento Co., California, elevation 65 feet, when I noticed a dark female vigorously rejecting a courting male. I collected the two, and was astonished to find that the

female was a worn *P. occidentalis* of the "calyce" phenotype. Her phenotype is quite unambiguous and easily told from the 24 female *protodice* collected the same afternoon, which represent a large range of variation from summer to "vernalis" phenotypes. The habitat is annual grassland and foothill woodland developed on dredge tailings, and is a classic locality for large populations of *P. protodice* breeding on the weedy mustard *Brassica geniculata*. No other *occidentalis* were observed alive, and no *occidentalis* tendency appeared in a sample of 76 *protodice* collected for study in an hour.

The nearest 6000-foot contours on the map are 50–70 miles from Rancho Cordova (USGS 1:250,000 "Sacramento" topographic sheet). *P. occidentalis* of similar phenotype and in mixed condition were still flying in Donner Pass at 7000 feet on 15 October 1976. Prevailing winds during the week prior to the record were very light northeasterly, i.e., downslope, and weather conditions were clear, warm, and dry. My trip was not pre-scheduled so there is no chance of a deliberate release having been made as a hoax by a student, and in the huge *protodice* population any deliberate release would probably not have been recognized. I see no alternative but to regard this as an extreme instance of individual long-range dispersal in a non-migratory species. The fact that it turned up in what is probably the best *protodice* habitat on the floor of the Sacramento Valley suggests habitat selection by the female once she did get down near sea level, since the ecologies of the two species are so similar. How many such individual dispersals actually occur? And what are the potential consequences, say for gene flow, of events which are so unlikely to come to our attention? Records indicating long-range dispersal, properly documented, are not trivial, and have considerably more scientific value than their traditional role as bizarre additions to local lists.

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THE BEHAVIOUR OF AN INEBRIATED *OPSIPHANES CASSIAE* (BRASSOLIDAE)

A female of *Opsiphanes cassiae* L., known in Costa Rica as "mariposa pacayera" or palm butterfly, drifted at dusk from the forest into a room where it flew and perched in places where light was subdued, until it arrived at a table where a bottle of a sound red wine (Rubion, Paul Masson, California, alcohol 12%/vol.) had been recently uncorked and left to breathe. The insect circled the bottle a few times before landing on the table surface and assuming a normal resting position. I then placed a drop of wine some 10 cm away from the butterfly which shyly retreated from my hand, remained motionless for a moment and then approached the drop, extended its proboscis and drank at its leisure. After some five minutes there were obvious changes in the behaviour of the insect.

First, some very slow up and down flapping of wings, followed by forewings being lowered and directed forward with brisk movements several times, hindwings remaining upright. With forewings in this position, the hindwings also moved forward, without lowering, until these were propped far ahead of their normal resting position. The abdomen remained motionless. Antennae were lowered until they touched the table and then shot backwards. Movement of fore-, hindwings and antennae were repeated several times in the same order of events.

After a brief period of inactivity, a hopping spastic side-walking took place alternating with wing and antennae motions as well as a tremulous and agitated moving of the legs. More wine was offered to the insect which sipped it directly from my fingertip after a somewhat hesitant uncoiling of proboscis. Another sequence

of the behaviour described above was observed until all wings were placed flat on the table although they were not limp and flaccid. A few forward strokes of forewings followed by a very fast vibratory flapping preceded a period of inaction. A few minutes later the butterfly took flight in a close-spiralling pattern towards an incandescent light, hitting the hot bulb several times, alighting and again attempting flight to the light source close to which it finally perched. After a few hours it resumed normal behaviour and flew away the next day.

As these butterflies, like other Brassolidæ, feed, among other things, on fermenting juices of fruit, it would be interesting to determine the alcoholic content of some of their foods and the possible influence on butterfly behaviour and survival in nature.

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OBITUARY

PROFESSOR PHILIP M. SHEPPARD, D PHIL, FRS (1921-1976)

Philip Sheppard's most enduring human achievement was to apply his interest in the workings of natural selection to the solution of a medical problem: by considering the way natural selection operates on blood groups through the interactions of mother and foetus, he and Sir Cyril Clarke invented and then successfully developed the 'Liverpool jab' which prevents rhesus haemolytic disease of the newborn, up to now a major cause of miscarriage, infantile death, and brain-damaged children.

Professor Sheppard's research in evolution was very much in the Darwinian tradition: a blend of experimental science and natural history which greatly valued the accumulated wisdom of naturalists, both amateur and professional. He thought of Lepidoptera as extremely valuable research tools in this respect, and used them more than any other group: in contributing to evolutionary biology by using Lepidoptera he contributed immensely to the field of lepidopterology, in which his monumental achievement (again mainly in collaboration with Sir Cyril Clarke) has been the elucidation of the genetics and evolution of mimicry, chiefly in three of the extraordinary polymorphic *Papilio*, now rounded out by studies of *Hypolimnys* and (posthumously) of *Heliconius*. This work has been a brilliant confirmation and extension of the theories of mimicry propounded by A. J. Nicholson, R. A. Fisher, and E. B. Ford, with the last of whom Sheppard did his doctoral research in Oxford (taking a D Phil in 1951) after serving during the second world war first in the RAF (Volunteer Reserve) and then as a prisoner of the Third Reich (he used to say, when lecturing on warning coloration, that what a man regarded as palatable depended on how hungry he was).

His first studies included a now justly famous demonstration (in collaboration with A. J. Cain) that characteristics which most biologists thought of as trivial (in this case the colour and striping of the shells of terrestrial snails) could be of considerable adaptive importance to the organism and could be subject to detectable natural selection. This aspect of his work has been the one most widely followed by other workers, Cain and he having founded in effect, a college for the study of micro-evolution in snails. His book, *Natural selection and heredity*, which integrates this work into that of the 'English' school of evolutionary genetics, has been widely used by students.

Sheppard spent some time on fieldwork, research and teaching in South East Asia, the United States, Finland, Trinidad, Brasil and other parts of the neotropics; most of his work was carried out at the University of Liverpool, which he joined as a senior lecturer in 1956, becoming Professor of Genetics in 1963. There he embarked on his wonderfully fruitful collaborations with C. A. Clarke on the genetics of people and of butterflies. He was elected to a Fellowship of the Royal Society in 1965, and was awarded the Darwin Medal in 1974.

During his long fight against leukaemia his abnormal energy and enthusiasm for scientific enquiry continued with no noticeable diminution. Much work remains to be published by colleagues: the appended bibliography (which is probably incomplete even for earlier works) shows an outline of his achievements.

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OBITUARY



PETER J. HERLAN (1909-1977)

Peter J. Herlan, Curator of Natural History at the Nevada State Museum, three times host of meetings of the Lepidopterists' Society, and highly respected member of the Pacific Slope Branch, died 4 April 1977, at age 67.

Peter Herlan was born in Seattle, 14 December 1909. He majored in botany at the University of Washington, where he was a member of the swimming team and played football on a Rosebowl team. He served as a seaman in the Merchant Marine and as an Inspector for Boeing Aircraft. During the Second World War he enlisted in the Air Force, served as a gunner, and was wounded in action.

He moved to Nevada in 1946 on the advice of an Air Force physician, for the benefit of the dry climate on his wounds.

He first worked for the Nevada Museum as a driver of a mobile unit for museum exhibits that toured the state. He later became Curator of Natural History. He had extensive field experience with plants, birds, and mammals, but was best known for his work with insects, especially the butterflies. He led numerous field expeditions for the Nevada Museum. Upon the retirement of James W. Calhoun as Director of the Museum in 1973, Peter Herlan was Acting Director of the Museum for two months, until a permanent Director was chosen.

Under Peter Herlan's direction, the collections and exhibits of the Nevada State Museum were greatly enlarged and improved, and extensive cooperation between the various museums and with the University of Nevada was maintained, so that exhibits were set up for public viewing. He also was instrumental in backing conservation legislation at the state level.

Peter Herlan described one butterfly subspecies, naming the very distinctive *Limenitis archippus lahontani* Herlan (1970 [1971]; J. Res. Lep. 9: 217-222). He has had one named in his honor, *Phyciodes orseis herlani* Bauer, and another has been proposed by Kurt Johnson (in press).

Pete, as he was affectionately known to his many friends and colleagues, was the only truly active lepidopterist residing in Nevada. Under his leadership, the meetings of the Lepidopterists' Society were held three times in Carson City with the Nevada State Museum as host. The Pacific Slope Meetings were held there in 1964 and in 1976. The combined National and Pacific Slope Meetings were held there in 1970.

Pete's knowledge of the remote corners of Nevada, and his and Barbara's hospitality, made the Nevada Museum, and at times the Herlan's home, the point of departure for many collectors visiting Nevada. Pete worked closely with many other students of butterflies, including David Bauer, the late O. E. Sette, and others; and the results of their studies have done much to help clarify the problems relating to Nevada Lepidoptera.

Pete was a loyal friend, one of nature's gentlemen, cheerful, outgoing, and always willing to help. He will be greatly missed by all who were fortunate enough to have known him.

He is survived by his wife Barbara, of Carson City, and by three sons, several grandchildren, and two sisters.

J. W. TILDEN, *125 Cedar Lane, San Jose, California 95127.*

BOOK REVIEW

A FIELD GUIDE TO THE BUTTERFLIES OF THE WEST INDIES, by Norman D. Riley. 1975. Quadrangle/The New York Times Book Co., 10 East 53 St., New York, N.Y. 10022, 224 p., illus. + 24 plates. Price \$12.50 (U.S.).

Although Riley's *Butterflies of the West Indies* is a welcome addition to the literature of the butterflies of the area, it has several shortcomings that detract from the usefulness of the book. These shortcomings will be discussed section by section.

Illustrations. In general the illustrations by Gordon Riley were found to be very good, but those by Brian Hargreaves, especially of the Satyridae and the Lycaenidae, left a lot to be desired. In some cases, it is doubtful that they will help identify the species involved.

Introduction. The introduction is very good. The only criticism is that on Fig. 2 the veins of the wings are identified in the usual European manner, i.e., using numbers. This might not create any complications, except that in the key to the families the veins are identified by their names. For the specialist this inconsistency will not pose any problem, but for the amateur it probably will.

Glossary. The glossary was found to be satisfactory.

Taxonomic discussions. In the taxonomic discussions many errors and omissions were found. Some of these might be because the author apparently has not done a great amount of collecting in the area and has worked mostly with preserved museum specimens and the available literature. This method of obtaining information about the biology of an area is not the best one, but in this case it is probably excusable because the West Indies are a politically and geographically heterogeneous group of islands where travel to some of the smaller islands is very difficult, expensive, and time consuming.

What is not excusable, are those errors and omissions that pertain to islands such as Cuba, Jamaica, and Puerto Rico which have rather well known lepidopterous faunas. The more obvious errors and omissions are the following: *Danaus gilippus cleothera* is not mentioned from Puerto Rico, although it has been reported before; *Danaus cleophile* is reported from Puerto Rico where it does not occur, the specimen reported in the literature as belonging to this species was described by Clark in 1941 as *Danaus plexippus portoricensis*.

Lycorea ceres cleobaea is reported from Jamaica. As far as I know, this is the first time this butterfly has been reported from the island, but no additional information is given about the new record.

Prepona antimache insulicola is placed in synonymy of *Prepona amphitoe* Godart 1823, this I find to be correct, but Puerto Rico is not included in the distribution of the species even though it has been reported many times from the island.

Marpesia petreus is a common butterfly in Puerto Rico, not a rare one as is stated in the book.

There is no subspecies of *Eurema dina* present in Puerto Rico. Therefore, the statement that the black border is present in the hindwing only in the Puerto Rican subspecies is erroneous. The species present in Puerto Rico is the closely related *Eurema leuce sanjuanensis*, which does not have a black border in the hindwing. Probably the author was confusing *E. dina* with *Eurema portoricensis*, the male of which has a black border in the hindwing.

Although admittedly seasonal, *Kricogonia lyside* is a very common butterfly in Puerto Rico. The statement that the records of *K. lyside* of Cuba should probably refer to *K. cabrerai* is erroneous. Salvador de la Torre was one of the first lepidopterologists to consider *castalia* and *lyside* as conspecific. He published a paper on the genus *Kricogonia* in Cuba in which he clearly distinguished between *lyside* and *cabrerai*.

Aphirissa statira cubana breeds in Puerto Rico, where it has been found to breed

on "quenepa" (*Melicocca bijuga* L.) and in *Cassia* sp. Therefore, the statement that the specimens collected in Puerto Rico are migrants is incorrect.

Battus polydamas is present in Puerto Rico as subspecies *thymus* Rothschild & Jordan, not as subspecies *policrates* Hoffer.

Papilio machaonides is reported for the first time from Puerto Rico, but again no additional information is given, even though the butterfly used in the illustration is a male apparently collected in Puerto Rico. *Papilio androgeus epidaureus* occurs in Puerto Rico, but the island is not included in the distribution of the species.

The statement that *Epargyreus zestos* is not present in any of the Greater Antilles is incorrect, it has been reported from Puerto Rico by Wolcott (*The Insects of Puerto Rico*), Comstock (*The Insects of Puerto Rico and the Virgin Islands. Lepidoptera Rhopalocera*), and Brown and Heineman (*Jamaica and its Butterflies*). Comstock, and Brown and Heineman also report it from Hispaniola.

Ephyriades zephodes is reported as present in Puerto Rico although the only record that I know is a single specimen at the British Museum, however *E. arcas philemon* which is a rather common skipper in Puerto Rico is not reported as present in the island.

Synapte malitiosa malitiosa is not reported from Jamaica, although it has been reported by Brown and Heineman to be rather widespread on the island.

Euphyes singularis insolata is reported for the first time from Puerto Rico, but again the information is rather scanty.

Panoquina panoquinoides panoquinoides has been collected in Puerto Rico a number of times but it is not listed as present on the Island.

Checklist. The checklist has also some errors and omissions. In some cases, species reported from an island in the discussion are not included under that island in the checklist (e.g., *Danaus gilippus jamaicensis* and *Cyanophris crethona* from Jamaica, *Strymon acis mars* and *Euphyes singularis* from Puerto Rico). On other occasions, species not reported from an island in the discussion are included in the checklist for the island (e.g., *Cyanophris crethona* from Hispaniola and *Polites dyctinna* from Puerto Rico). There is some inconsistency on what is considered doubtful or vagrant, e.g., *Authohton neis*, *Colgia calchas*, and *Nisoniades bessus* are considered vagrants in Jamaica, and *Antigonus nearchus* is considered as doubtful. But all of them are considered as doubtful by Brown and Heineman because they doubted the correctness of the locality labels of the specimens in the British Museum.

Some misspellings were found throughout the checklist: *Urbanus tellus* instead of *teleus*, *Anetia briaria* instead of *briarea*, and *Calisto herophilus* instead of *herophile*.

Bibliography. The bibliography is good, it includes the most important references for the area.

In summary, I consider this a good book which could have been an excellent one if the author had paid more attention to certain details.

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The object of the Lepidopterists' Society, which was formed in May, 1947 and formally constituted in December, 1950, is "to promote the science of lepidopterology in all its branches, . . . to issue a periodical and other publications on Lepidoptera, to facilitate the exchange of specimens and ideas by both the professional worker and the amateur in the field; to secure cooperation in all measures" directed towards these aims.

Membership in the Society is open to all persons interested in the study of Lepidoptera. All members receive the *Journal* and the *News of the Lepidopterists' Society*. Institutions may subscribe to the *Journal* but may not become members. Prospective members should send to the Treasurer full dues for the current year, together with their full name, address, and special lepidopterological interests. In alternate years a list of members of the Society is issued, with addresses and special interests. There are four numbers in each volume of the *Journal*, scheduled for February, May, August and November, and six numbers of the *News* each year.

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Memoirs of the Lepidopterists' Society, No. 1 (Feb. 1964) A SYNONYMIC LIST OF THE NEARCTIC RHOPALOCERA

by CYRIL F. DOS PASSOS

Price: Society members, \$5.00 U.S.; non-members, \$7.50 U.S. Paper covers, revisions of the Melitaeinae and Lycaenidae supplied separately.

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

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PRESIDENTIAL ADDRESS 1977: THIRTY YEARS AND COUNTING¹

S. S. NICOLAY

1500 Wakefield Drive, Virginia Beach, Virginia 23455

During the early summer of 1947, some 100 lepidopterists, amateur and professional alike, received a mimeographed, 12-page document, dated May 1947 and entitled, *The Lepidopterists' News*. Across the top of the page, placed squarely beneath the masthead were the words in full capital letters—WELCOME TO CHARTER MEMBERSHIP IN THE LEPIDOPTERISTS' SOCIETY.

For this document and the promise of more to follow, we had each paid the magnificent sum of \$1.00 for a full year's subscription! Volume 1, number 1 contained 12 typewritten, mimeographed pages. The format set the tone for the remainder of the year's output. The first paragraph on page 1 presented a very clear picture of what was to follow:

"Here is the first number of the periodical announced in the March letter. The first few numbers, like this one, will each contain twelve mimeographed pages, and in this first issue are several of the regular features which are planned for your interest and enlightenment. On page 3 is the review of Ford's *Butterflies*, which will be followed regularly by reviews of other books of direct interest to lepidopterists. Pages 4-7 carry monthly notices of papers on Lepidoptera in the current literature. Page 8 contains the first of a series of brief biographies of important American and foreign Lepidopterists. Page 9 introduces a series of discussions on life history studies of Lepidoptera, concerned more with methods of study than with published papers and books. Pages 10-12 are devoted to collecting trips planned by members, your list of exchange notices and other requests, and miscellaneous items. We urge you to contribute items for these pages. In the serial subjects,

¹Read at the Annual Meeting of the Lepidopterists' Society in Boulder, Colorado on 24 July 1977.

such as on pages 3, 8 and 9, we expect to be able to present articles by authorities on specific phases of the subjects. The final issue of the year will be accompanied by a list of the names, addresses, and special interests of all members."

By the end of the year, the initial 101 members of May had grown to 220, the *News* page total had reached 117 and contained an incredible wealth of information, most of it as timely and interesting today as it was then. To determine how well the original concept has held up, one need only read our present-day *Journal* and *News*.

As most, if not all of you, are aware, the Lepidopterists' Society was initiated by Dr. Charles L. Remington, then a graduate student at Harvard. During the first few months of its life, the entire staff of the Society, editorial and administrative, consisted of three people: Charles Remington and Harry Clench, editors and Mrs. Jeanne Remington. In September of the first year, Harry Clench moved to Michigan and the entire work of publishing the *News* and conducting Society business was accomplished by the Remingtons.

In 1948, dues went from the original \$1.00 to \$2.00 in order to, as Charles Remington so aptly put it, "provide urgently needed typographical help for the enormous task of preparing the final copy of each *News* for the lithprinter without reducing the size of the *News* volume." Some additional editorial help was added in the personages of Peter Bellinger, Dr. Diakonoff, C. F. dos Passos and Takashi Shirozu who assisted in examining the large number of scientific journals, and abstracting all papers on Lepidoptera to be included in the *News*. Total membership in the Society nearly doubled by the end of 1948 to 397. Volume 2 contained a total of 124 pages.

Thus did the Lepidopterists' Society and its publication, the *News* continue in almost the same format under the guidance of its primary founder until 1950. It had, however, become apparent for some time that the task of publishing the *News*, in addition to performing all other administrative functions was more than two could handle; some issues in late 1949 and most numbers in 1950 were combined and even then some appeared late. Early in 1950, Cyril F. dos Passos prepared a draft constitution and by-laws, and the president pro-tem, Dr. J. H. McDunnough appointed 3 temporary committees to prepare for the first annual meeting. At the meeting, held in New York on December 29-30, 1950, ballots previously mailed to all members were counted and the first full slate of officers in the Lepidopterists' Society were duly elected and took office. Just a little footnote of sadness to the above—in looking over the names of the officers, I note that only our first secre-

tary, Dr. Fred Rindge and our first elected treasurer, Dr. Ben Ziegler are still living.

In 1951, the *News* took on a different look with an attractive grey paper cover. The efforts of editors, Charles and Jeanne Remington, were assisted by associate editors, F. Martin Brown, Peter Bellinger and Eugene Munroe. Volume 5 contained 126 pages, plus a membership list of 15 pages. Total membership had reached nearly 500.

The year 1952 brought the first radical change in appearance to the *Lepidopterists' News*: volume 6 was, for the first time printed in typeset on a high grade, slick paper in the 6 by 9 inch format we are all familiar with in today's *Journal*. And, although it was not clearly stated, it had become obvious that the *News* was becoming a quarterly publication with 2 and sometimes as many as 3 numbers combined and mailed together in a single issue. Presentation of material and format remained essentially the same for the next 5 years. Elections of officers were held each year to fill vacancies as they occurred in the various offices as well as in the Executive Council. In 1955, with volume 9, dues for regular members, which had been raised to \$3.00 in 1952, were raised again to \$4.00 per year.

Volume 12 in 1958, although carrying the masthead of the *Lepidopterists' News* was the final issue to appear in the now familiar format and was, in fact, the precursor for our current *Journal*. Beginning with volume 10 in 1956, the membership list was already being mailed separately as a mimeographed list of sizeable proportions. Volume 12, issued in 3 parts of 2 numbers each, contained a total of 240 pages and set the model for the *Journal* that followed. The *News* as we know it today began publication at this time with Dr. J. W. Tilden as editor. This new *News*, economically mimeographed or multilithed, provided the vehicle for material of a temporary nature but of immediate interest; the *Journal* was a continuation of the old *News* with no major change in format, content, size or editors. Volume 13 in 1959 appeared for the first time with the masthead of *Journal of the Lepidopterists' Society*. Issued quarterly, it carried a total of 256 pages.

From 1960, when dues rose to \$5.00 per year for regular membership and then to \$6.00 the following year, publication costs remained relatively stable for the next 10 years. The cost of a Sustaining Membership, which, by the way, has always been one of the most beneficial ways of helping the Society financially, remained steady at \$15.00 for the 10 years between 1961-1971. Total membership remained within the 500-600 bracket for about 6 years, between 1952 and 1959. From

that time until the present, the Society has grown at the rate of a bit less than 10% per year.

But, enough of figures and statistics. For those who really wish to go into the statistical history of the Society in complete detail, I recommend a copy of our Commemorative Issue. And, on this subject, I come to the main point of this presentation. The Society has, in recent years, experienced increasing difficulty in finding qualified members willing to give of their time and talents in order that the Society might continue to function smoothly and efficiently. The Commemorative Issue, originally conceived to celebrate our 25th anniversary, has been 6 years in the works; we now hope to have it in the hands of individual members before the end of this, our 31st year! This is not meant as an indictment of those who have expended so much time and effort to see it published; on the contrary, I would hate to try to estimate the incredible number of hours and days Roy Kendall has put into this project. And he is but one of a number who have had a hand in its creation. I use the example of the Commemorative Issue to amplify the following point.

As President of the Society for the past year, I have, with the help of other council members, tried to find a successor for two of our most critically important officers, the Editor of the *Journal* and our Treasurer. We have written letters, made personal contacts and appeals, and otherwise have attempted by those limited means within our reach to find suitable and qualified personnel to fill these most critical positions. The 3-year terms of our Journal editor, Dr. George Godfrey, who has done such an outstanding job these past years and that of our Treasurer, Dr. John Snider, who has paid our bills and kept us solvent, will expire on 1 January 1978. At the time this was written, we had not been able to find interested and suitably qualified members willing to accept these positions.

The Lepidopterists' Society is now, and always has been, a non-profit organization. It has no salaried officers or employees, and all work is accomplished by members of the Society on a voluntary basis. My purpose in presenting the brief history of the growth of the Society was to illustrate that the *needs* of the Society also grew throughout the years, as did its size and the scope of its endeavors. These needs were not only monetary, as illustrated by the steady increase in dues from the original sum of \$1.00 to the current \$13.00; the Society, from its original 2-man operation has now an elected, functioning Executive Council or Staff, however you wish to call it, of 15 officers plus two separate editorial staffs, one for the *Journal* and one for the *News*.

As in most organizations, certain staff positions require more time and work than others, but all contribute their time and efforts without salary or remuneration of any sort.

A number of entomological societies have flourished in years past but have eventually disappeared. I do not know the detailed history of any of them, but I would make an educated guess that the most common cause of their demise was a lack of interest . . . a lack of interest by the membership at large in seeing to it that the organization survived those crises, fiscal or organizational, that occasionally arise in every society from time to time. Payment of dues and the money derived therefrom is vitally important for survival of any society of this sort; but no less so is the active and continued support of its members who give of their *time* as well as their money. A careful reading of Dr. Snider's fiscal report for the past 3 years indicates that we paid our bills, that our income exceeded our expenses by a reasonable and fair amount and that we have a comfortable, if not excessive, balance to our credit. Dr. Snider has declined, and rightfully so, to continue beyond his 3-year term of office.

It is with an audible sigh (Thank God) of relief, that I can now report to you that 2 days ago one of our members volunteered to have his name placed on the ballot for the coming year in the position of Treasurer, to serve for the next 3 years.

Just a few days ago I received a letter from an individual requesting information on membership in the Society. It was a very short letter and I will quote it in part:

"Dear Sir, I am writing to find if you are still associated with the Lepidopterists News/Journal. I would like to get membership but my letter to Sarasota, Florida was returned stamped unknown. I realize the issue I used is old, but I can't believe this paper has quit."

Ladies and gentlemen, I too, find it hard to believe that this 'paper' is even near quitting. I find it hard to believe that out of a total membership that must now be in the neighborhood of 1200 plus, there are not a number of individuals with talent, experience and, most of all, the desire to serve in order that the Lepidopterists' Society will survive. Even if the current crises were solved today (and I believe that they will be) I can foresee many similar difficulties in the future unless more members, particularly the younger and/or newer members of the Society find it also interesting and rewarding to serve with their time and talents in addition to just paying and receiving.

This message is designed to reach each and every member of the Society. Those of you here in Boulder listening to this, are, for the most

part, those who have and/or are serving the Society in many ways. To those of you who will read this . . . when a member of the Executive Council contacts you with a request for your help in whatever capacity it might be, please reconsider that initial urge to say, "No." Most of us find that 24 hours in one day, just aren't enough to accomplish all that we would like. So consider joining those who are in that same boat, for it is the busiest individual of all, who seems to find the time to add one more task to the growing list, and serve.

NOTES AND NEWS

Editorial Farewell

Three years ago the Society asked me if I would take the editorship of the *Journal*. I received such an impressive letter about my qualifications for the position that I felt compelled either to accept or tell the individual who wrote to me that he was a liar. I finally agreed to take the responsibility, hoping that if I did a respectable job we would both save face.

At the close of my term as your editor, I want to thank my associate editors, the reviewers, and other members of the Society plus several non-members who assisted and encouraged me during the past three years. Based on letters and comments that I have received, the *Journal* has remained the best publication solely devoted to Lepidoptera. The quality of the *Journal* is a reflection of those persons who have supported me. I especially want to single out William H. Allen for functioning as my technical editor in spite of his hectic schedule as a budding journalist. For the current volume I thank Paul H. Faber for providing the cover illustration of Abbott's Sphinx, *Sphecodina abbottii* (Swainson).

It is my pleasure to announce that Dr. Austin P. Platt will be the new editor effective 1 January 1978. More information about Dr. Platt will appear in the *NEWS*. I wish him the same cooperation and assistance that I received. Please see his special notice to contributing authors on page 274 of this issue.

George L. Godfrey

PHENOTYPIC WING PATTERN MODIFICATION BY VERY
BRIEF PERIODS OF CHILLING OF PUPATING *ARICIA*
ARTAXERXES VANDALICA (LYCAENIDAE).
ARICIA STUDIES NO. 16

OVE HØEGH-GULDBERG AND ARNE LINDEBO HANSEN

Natural History Museum, Aarhus, Denmark

Since Dorfmeister "in 1845" showed that divergent forms were developed when butterfly pupae were kept at increased or decreased temperature, many scientists have worked on this problem because the effect of temperature might explain some of the aberrant forms which now and then are found in natural populations. Some important papers on temperature-induced forms in Lepidoptera are referred to below that concern the age of the pupa at the time of cooling, the temperature used, and the duration of the treatment.

Merrifield (1893) and Standfuss (1896) independently found that pupae chilled immediately after pupation died or produced crippled but normal-patterned imagines. To obtain altered imagines the pupae were chilled not earlier than 12 hours (h) after pupation, when the sensitive period begins. The chilling must continue for at least 14 days. Süffert (1924), working on *Araschnia levana* L. and *Aglais urticae* L., found a sensitive period some days after pupation; there was no effect with earlier chilling. The cooling period was 10 days. Reinhardt (1969), who definitely solved the problems of *Araschnia*'s seasonal dimorphism, only conducted a few experiments with pupae as young as 0–6 h; the other experiments were from 6–36 h after pupation. Kühn (1926) also found no changes in Vanessinae if cooling took place immediately after pupation. The effect increased from 6–24 h after, but there was no effect after 72 h. The temperature used was low, from -3 to -10°C , for two days. Very exact experiments were conducted by Köhler & Feldotto (1935), who, working on Vanessinae, found the heat-sensitive period to be from 0–48 h after pupation. Every pattern element was found to have its special sensitive period. In these experiments only increased temperature, for short periods, was used. In most of these experiments only Nymphalidae were examined, but Merrifield also investigated Geometridae and Kühn also worked with certain moths.

Krodel (1904) performed experiments with three species of Lycaenidae: *Plebeius* (*Lycaena*) *argus* L., *Lysandra* (*Lycaena*) *coridon* Poda, and *Agrodiaetus* (*Lycaena*) *damon* Schiff. The pupae were never less than 5 h old; in the course of 6 days and nights they were exposed to 12

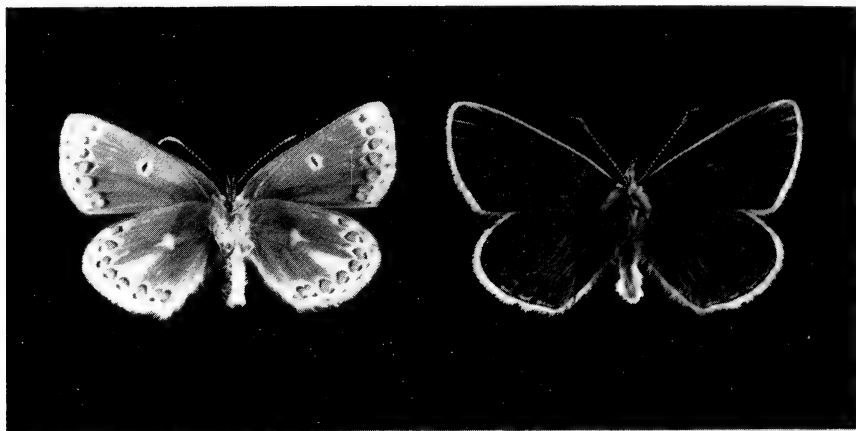


Fig. 1. Wild rare forms of *Aricia artaxerxes vandalica*: (left) ♀, underside, Tversted Strand, Jutland, 16 July 1961, spot value 3—f. "caeca"; (right) ♂, upper-side, Tornby Strand, Jutland, 11 July 1960, f. "albicostalis" (= "albivenata").

cold spells each of 6 h duration, during which the temperature went down to -14°C . In this way Krodell produced numerous cold forms, partly corresponding to forms taken in the open, and he was of the opinion that these forms could be explained as ancient characters which for many generations have remained latent, but which reappear under certain circumstances, such as cold treatment. Lorkovic (1938) found obsolescence of eyespots by cooling pupae of *Polyommatus icarus* Rott. Høegh-Guldberg (1971) cooled pupae (1–24 h old) of the same species at $+2$ to $+5^{\circ}\text{C}$ for 4 weeks and observed many changed imagines. Lorkovic (1943) observed reduction of eyespots by cooling—for 3 weeks—"young" pupae of *Everes argiades* Pall.

Another genus of Lycaenidae is *Aricia*, and the following deals entirely with *A. artaxerxes* F. and *A. agestis* Schiff. These are two closely related species widely distributed in Europe. In both species, but especially in some *A. artaxerxes* populations, aberrant forms occur quite often. Two rare forms are depicted in Fig. 1, to be compared with the normal appearance, Figs. 2A & D. It is shown in Fig. 2D that the blackish upperside has marginal lunules most distinct on the hindwings, and without the white nervures at the tip of forewings which are seen in Fig. 1. The normal underside, Fig. 2A, has a complex system of eyespots when compared with the aberrant form in Fig. 1. This eyespot pattern varies gradually from that extreme; the degree can be expressed as "spot value," which registers the number of spots and centres on one forewing and hindwing, including all pupillations plus the sum of their centres. Maximum is 42:

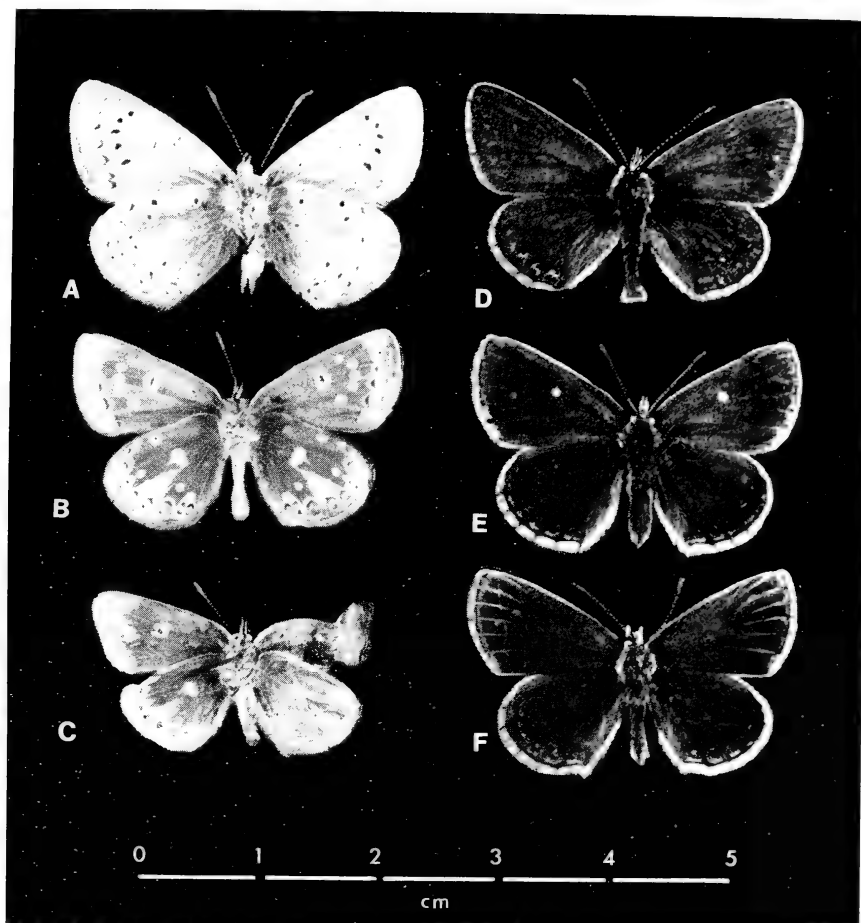


Fig. 2. Wild average forms and chilled specimens of *Aricia artaxerxes vandralica*. Undersides: (A) ♂ from nature (61,60), Tornby Strand, Jutland, 4 June 1961, spot value 25, normal form; (B) Pl ♀ (73,61), ex Tornby Strand, pupa 1 min, chilled 9 h, spot value 12; (C) Pl ♀ (73,125), ex Tornby Strand, pupa 15 min, chilled 2 "nights," spot value 3, f. "caeca." Uppersides: (D) ♂ from nature (66,53), Tversted Strand, Jutland, 6 July 1966, no white elements, normal form; (E) Pl ♀ (73,59), ex Tornby Strand, pupa 1 min, chilled 2 "nights," f. "snelleni," f. "panalbisignata"; (F) Pl ♀ (73,62), ex Tornby Strand, pupa 1 min, chilled 9 h, f. "albicostalis" (= "albivenata").

1 + 1, 7 + 7 (counting the lowest double discal spot as 1); hindwing 4 + 4, 1 + 1, 8 + 8 (the second discal spot from below is counted as 1 even if double). It is very rare to find a spot number exceeding 38. The minimum is 3—only the two discoidal spots remain, the hind one without

pupil (f. "panobsoleta" (= "caeca") + f. "carteri"). In *A. artaxerxes vandalica* the normal spot value varies from 26 to 33 with nearly equal representation of each value and very few individuals with lower or higher counts.

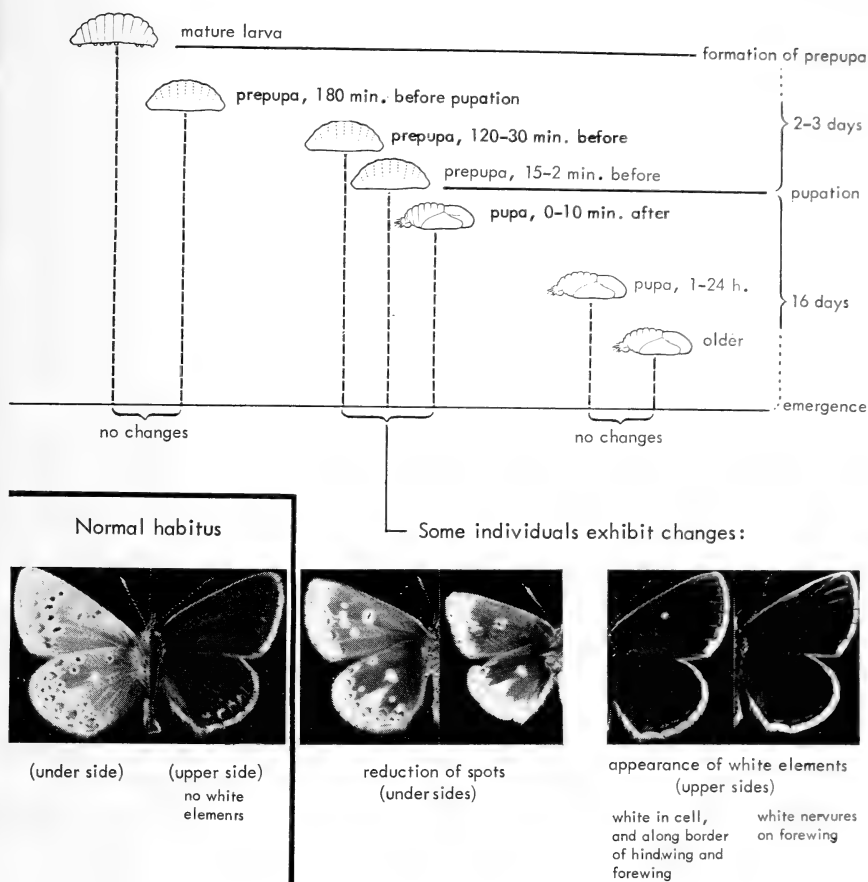
Jarvis and Høegh-Guldberg have conducted numerous experiments by rearing large series of butterflies from eggs of both species. Young pupae have been cooled for various periods, but pupae less than 1 h old have been avoided because they are very fragile. Jarvis (1959) demonstrated that four conditions had to be fulfilled if changes are to be obtained: (1) temperature must be constant, (2) it must be +1 to +3°C, (3) the cooling period must be 20 days or more, (4) the age of the pupa must be 1–2 h (or up to 24 h), but most extreme results are obtained in the younger pupae.

Høegh-Guldberg (1968), after examining large numbers of bred sibs, confirmed this. He also had the same results at +2 to +5°C, and he added a fifth condition: that a positive result also depended on a particular genotype in the individual and in the population. Jarvis also suggested that extreme forms, such as f. "caeca" (Fig. 1, left) found in the wild, might be due to accidental cooling on cold nights during a critical phase of pupation. This was a tempting theory, but in experiments such a phase of short duration had never produced these forms. Since pupation in nature in these species takes place in the early summer, where a long-lasting, very low and constant temperature is not found, it seemed impossible to explain aberrant wild forms as cold forms. Later, other experiments by Høegh-Guldberg & Jarvis (1969), with conditions which might occasionally be found in nature, also produced no changes in the imaginal pattern. These experiments were with prepupae (24 h before pupation) and pupae (2–12 h after pupation), cooled at various temperatures for shorter periods. Thus, still no possibility existed for explaining natural aberrant forms as the result of cold.

But a solution to the problem was found by starting cooling just around the time of pupation. At that time the sensitivity is so high that only a short cooling sometimes suffices to create changes in the imaginal pattern (Fig. 3). First the author (Høegh-Guldberg, 1974a) had to establish the timetable for pupation of *Aricia* by careful observation of prepupae; thus it is possible to judge when the shedding of the larval skin will occur.

EXPERIMENTAL PROCEDURE

One hundred and thirty-four specimens of *Aricia artaxerxes vandalica* were reared in single vials indoors from eggs laid by two females from Tornby Strand and Skallerup Klit found on 17 June 1973. Thirty-three



The same forms (and many others) are created in most imagines, if 1-24 h. old pupae are constantly chilled for 2-4 weeks, and every imago exhibits some changes if the chilling period is 6 weeks.

Fig. 3. Effect of chilling *Aricia artaxerxes vandolica* at $+2$ to $+5^{\circ}\text{C}$ for 1, 2 or 3 "nights" and then returning to room temperature.

individuals served as controls; they were kept at room temperature ($+18$ – 20°C) until emergence. Seventy mature larvae and prepupae, whose time for pupation was judged from the appearance, and 31 pupae in the first minutes (min) after pupation were cooled at $+2$ to $+5^{\circ}\text{C}$ for one, two, or three periods of 9–12 h, the latter two cases with room-temperature periods of 12 h in between. All pupae were kept at room temperature for the remaining 14–16 days of the pupal period. Normally the pupation takes place at any time, so the start of cooling could be at

TABLE 1. The effect on "spot value" of cooling *Aricia artaxerxes vandatica* during critical phases of pupation.

Experimental treatments:			No.	Died	Crippled	No. with low spot value	χ^2	P	
Room temperature controls			33			3			
Cooling at +2-5°C									
Stage of development	Age in relation to time of pupation	Cooling periods "nights"							
Mature larva		2	5		1				
		3	8				0.1405	0.5	0.7
Prepupa	-2 days	2	4			1			
	-1 day	2	4				0.1388	0.5	0.7
	-2 to 1.5 h	1	3						
	-3 to 2.0 h	2	2		1				
	-2 h	3	4		1	2	0.2477	0.3	0.5
	-1 to 0.5 h	1	7		2				
		2	11	1	1	4			
		3	15		1	3	1.1758	0.2	0.3
	-15 to 2 min	1	3			1			
		2	3		1	3			
		3	1	1			7.8526		0.01
Pupa	0 to 10 min	1	16			5			
		2	7	1		3			
		3	8			1	3.1662	0.1	0.05

χ^2 is calculated from $n(|ad - bc|) - \frac{1}{2}n^2 / (a + b)(c + d)(a + c)(b + d)$

a = number of controls with normal spot value.

b = number of controls with low spot value.

c = number of experimental animals with normal spot value.

d = number of experimental animals with low spot value.

P is the probability that low spot values occur with the same frequency as in the control group.

any time of the day and night. These conditions are as close as possible to natural conditions occurring in early Danish summer, i.e., one, two, or three cold nights rising to 15-25°C in the daylight hours.

RESULTS

In some of the cooled imagines, differences were found partly in the presence of white elements of the upperside and partly in the "spot value." It is seen from Table 1 that in the cooled groups there is a tendency toward low spot values; this tendency is statistically significant at the $P < 0.05$ level just around pupation. Of the individuals with low spot values, the specimen in Fig. 2C is a true f. *caeca* (*panobsoleta*), a very rarely found form in nature. It had been cooled 15 min, before

TABLE 4. Mating status and free lipid content of a sample of 111 females collected at Site Alpha on 25-26 January 1977.

No. of spermatophores in bursa				Free lipids in abdomens		
0	1	2	3	None	Moderate	Considerable
85%	11%	2%	2%	24%	39%	37%

tain extent can override short daylength, oögenesis is minimal to absent at daylengths of less than 11-12 h and temperatures of less than 20°C (Barker & Herman, 1976). Site Alpha is at approximately 20° North Latitude where at winter solstice the light period is 10 h 48 min (Finch & Trewartha, 1949). By 1 February, daylength would be critical, i.e., ca. 11.3 h (Beck, 1968), with the stage set for the massive panmictic mating ceremony to be triggered by rising temperatures.

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The populations considered subspecies of *selene* actually represent aggregations of populations homogeneous in wing characters but on a larger scale representing the distinct clustering of characters amid broad clines. Subspecies names are valuable in characterizing these groups as to phenotypic appearance, habitats, and ecological-range affinities. Subspecies names are used in this paper for these reasons.

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Number of typical specimens examined							
Males	130	232	51	88	15	159	14
Females	63	166	8	53	6	80	1
FW length, mm							
Males	20.98	24.78	22.82	19.55	19.17	20.08	20.67
Females	21.85	25.73	23.75	20.46	20.08	20.57	21.50
Degree of maculation (dorsal) ¹	2.29	1.99	1.82	1.50	2.33	2.25	2.33
Degree of dark marginal wing scaling (dorsal) ¹	1.52	1.14	1.80	1.22	3.00	3.19	1.93
Degree of dark basal wing scaling (dorsal) ¹	1.70	.87	1.20	2.14	4.33	2.10	2.47
Percentage of specimens with basal spot in discal cell of dorsal HW obscured	30	6	15	79	100	60	93
Percentage of specimens with anvil-shaped silver spot in cell Cu ₂ of ventral HW divided	12	4	4	30	33	6	7
Yellow scaling invading cinnamon color of basal and discal areas of ventral HW ²	++	++	+++	+++++	++++	+	+

¹ Values represent an average obtained by visually rating each specimen on a scale of 0-5.² Average appearance of each subspecies based on a composite of all specimens examined.

marginal wing scaling, and dark basal wing scaling dorsally, given for each subspecies, represent averages of numerical values obtained by visually rating each specimen on a scale of zero to five. The values for the amount of yellow scaling that invades the cinnamon color of basal and discal areas of the ventral HW (hindwing) represent the average appearance of each subspecies based on a composite of all specimens examined. These are also on a scale of zero to five. Division of the anvil-shaped silver spot in cell Cu₂ of the ventral HW is not intended to be a main character for separation of subspecies. It is used to point out the close relationship of *albequina* (Holland) to *tollandensis* (Barnes & Benjamin).

TABLE 4. Mating status and free lipid content of a sample of 111 females collected at Site Alpha on 25–26 January 1977.

No. of spermatophores in bursa				Free lipids in abdomens		
0	1	2	3	None	Moderate	Considerable
85%	11%	2%	2%	24%	39%	37%

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FW length, mm							
Males	20.98	24.78	22.82	19.55	19.17	20.08	20.67
Females	21.85	25.73	23.75	20.46	20.08	20.57	21.50
Degree of maculation (dorsal) ¹	2.29	1.99	1.82	1.50	2.33	2.25	2.33
Degree of dark marginal wing scaling (dorsal) ¹	1.52	1.14	1.80	1.22	3.00	3.19	1.93
Degree of dark basal wing scaling (dorsal) ¹	1.70	.87	1.20	2.14	4.33	2.10	2.47
Percentage of specimens with basal spot in discal cell of dorsal HW obscured	30	6	15	79	100	60	93
Percentage of specimens with anvil-shaped silver spot in cell Cu ₂ of ventral HW divided	12	4	4	30	33	6	7
Yellow scaling invading cinnamon color of basal and discal areas of ventral HW ²	++	++	+++	+++++	++++	+	+

¹ Values represent an average obtained by visually rating each specimen on a scale of 0-5.² Average appearance of each subspecies based on a composite of all specimens examined.

marginal wing scaling, and dark basal wing scaling dorsally, given for each subspecies, represent averages of numerical values obtained by visually rating each specimen on a scale of zero to five. The values for the amount of yellow scaling that invades the cinnamon color of basal and discal areas of the ventral HW (hindwing) represent the average appearance of each subspecies based on a composite of all specimens examined. These are also on a scale of zero to five. Division of the anvil-shaped silver spot in cell Cu₂ of the ventral HW is not intended to be a main character for separation of subspecies. It is used to point out the close relationship of *albequina* (Holland) to *tollandensis* (Barnes & Benjamin).

TABLE 2. Comparison of width to height ratios¹ of median black lunules in cells Rs, M₁, M₂, M₃, and Cu₁ of the ventral FW of some North American *Boloria selene* subspecies.

	<i>myrina</i>	<i>nebraskensis</i>	<i>sabulocollis</i>	<i>tollandensis</i>	<i>atrocostalis</i>
Number of specimens examined	116	127	59	44	66
Cell Rs	1.34	1.37	1.38	1.20	1.32
Cell M ₁	1.27	1.38	1.25	1.22	1.17
Cell M ₂	1.58	1.70	1.49	1.51	1.51
Cell M ₃	1.12	1.12	.99	.90	1.00
Cell Cu ₁	1.21	1.28	1.04	.95	1.13

¹ Values obtained by dividing width of the lunule by height. Values greater than 1 indicate oblate lunules.

One of the more consistent characters used in the study was the shape of the median black lunules of the ventral FW (forewing) in cells M₂, M₃, and Cu₁, but especially in M₃ and Cu₁. The values given in Table 2 are averages obtained by taking measurements of each spot on every specimen using a binocular dissecting microscope with a micrometer disc grid in the eye-piece. These measurements of width and height of each individual spot were then adjusted to a ratio number by dividing width by height. Lunules that were oblate had numbers greater than one. Numbers near one or less indicated the lunules were not flattened and elongated.

Terminology used for describing veins, cells, and wing areas follows that given for butterflies in general and specifically for *Boloria* by Ehrlich & Ehrlich (1961).

No consistent or reliable characters which could serve to differentiate subspecies were found in the genitalia.

Boloria selene myrina (Cramer)

(Figs. 2, 6)

Papilio myrina Cramer, 1777, vol. 2: 141, pl. 189, figs. B., C.

Papilio myrinus: Herbst, 1798.

Argynnis myrissa Godart, 1819, p. 253.

Argynnis myrina: Scudder, 1863, p. 166; 1868, p. 379. Edwards, 1876, p. 161.

Brenthis myrina nubes Scudder, 1889, p. 595.

Brenthis myrina ab. *nubes*: McDunnough, 1938, p. 16.

Boloria selene myrina ab. *nubes*: dos Passos, 1964, p. 89.

Brenthis myrina: Dyar, 1900, p. 487. Cary, 1901, p. 307; 1906, p. 439. Elrod, 1906, p. 69. Franzen, 1914, p. 366. McDunnough, 1928, p. 274. Holland, 1931, p. 105. Clark, 1932, p. 102. dos Passos & Grey, 1934, p. 190. McDunnough, 1938, p. 15. Davenport & Dethier, 1938, p. 158. Leussler, 1938, p. 216. Rysgaard, 1939, p. 193. Comstock, 1940, p. 53. Brooks, 1942, p. 34.

Brenthis selene myrina: Clark, 1941, p. 384.

Brenthis selene marilandica Clark, 1941, p. 384.

Boloria myrina: dos Passos & Grey, 1945, p. 4.

Boloria selene marilandica: Klots, 1951, p. 89. dos Passos, 1964, p. 89.

Boloria selene myrina: Klots, 1951, p. 89. dos Passos, 1964, p. 89. Shepard (in Howe), 1975, p. 246.

Diagnosis. This subspecies is most closely allied to *nebraskensis* in coloration and pattern of markings. Series of the two are readily separated by size, since FW length of *nebraskensis* averages ca. 4 mm greater than *myrina* in both males and females.

The pattern of dorsal dark markings on the orange ground color of *myrina* is heavier than on *nebraskensis* and is comparable to *atrocostalis* (Huard). In the basal portion of the wings dorsally, *myrina* also has more dark scaling than *nebraskensis*, and the dark basal spot in the discal cell is frequently obscured with dark scales (ca. 30% of specimens). This spot is obscured in only 6% of *nebraskensis* specimens (Table 1). The black marginal band dorsally is a little heavier on *myrina* than *nebraskensis*.

In both subspecies, the black median lunules in cells M_2 , M_3 , and Cu_1 of the ventral FW tend to be elongated or oblate (Table 2). This tendency is less pronounced in *myrina* than in *nebraskensis*.

Male. Dorsal surface: ground color bright orange, with pattern of dark markings sharply demarcated; black wing margins of FW and HW not heavy, and enclosed row of orange marginal spots distinct and visible along entire margin; basal areas of both wings moderately dusted with dark scales, often obscuring basal spot in discal cell of HW.

Ventral surface: apical patch of FW solid cinnamon-brown, not infused with yellow scales; orange of FW ground color usually extending distally to cinnamon-brown apical patch without fading to yellow; black median lunules in cells M_2 , M_3 , and Cu_1 of FW oblate, elongated on long axis of wing; cinnamon-brown ground color of HW mostly solid, especially in basal area, with little dusting of yellow scales; postmedian row of light spots of HW all prominent and well silvered; anvil-shaped silver submedian spot in cell Cu_2 of HW seldom divided.

Length of forewing: 20.98 mm average.

Female. Similar to male but orange ground color of dorsal surface slightly more pale.

Length of forewing: 21.85 mm average.

Type locality. The type locality given by Cramer in his original description of *myrina* was New York. Cramer's specimen most likely came from southeastern New York, rather than northern New York, which was probably quite inaccessible at that time.

Holland (1928) felt that specimens in his possession from Hunter and Saratoga, New York, Pennsylvania, and other localities in New England agreed with the somewhat crude figure given by Cramer and accepted the Hunter and Saratoga specimens as being topotypical. Holland pointed out that the discal and basal markings of the wings on the upper side of these specimens were not as heavy as in Cramer's original drawing and that they more nearly represented the "general run" of specimens in New England and the Middle States. He also mentioned that he had specimens from Hunter, New York and the Allegheny Mountains near Cresson, Pennsylvania that were as heavily marked as the specimen shown on Cramer's plate. Specimens examined for this study from some localities, including Schuylkill Haven, Pennsylvania (Fig. 2) were similarly marked.

Distribution. Southern portions of New York, Vermont, and New Hampshire south to central Virginia and West Virginia, including Massachusetts, Rhode Island, Connecticut, New Jersey, Pennsylvania, Maryland, and Delaware, west through southern Michigan, extreme northeast Illinois, the southern portions of Wisconsin and Minnesota to eastern South Dakota (Fig. 1).

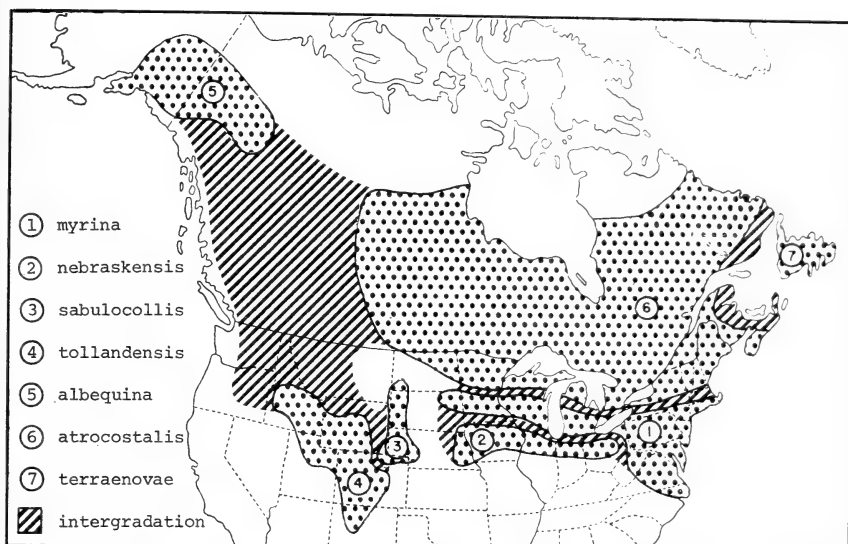


Fig. 1. Distribution of the subspecies of *Boloria selene* in North America.

Remarks. The subspecies *myrina* has been referred to by some authors (Klots, 1951; Shepard in Howe, 1975) as being average for the species in both size and markings. Because of this, many specimens representing intergrades between *atrocostalis* and *myrina* and between *myrina* and *nebraskensis*, as well as specimens of *nebraskensis* over much of its range, have been lumped together under *myrina*.

Specimens from central Ohio, northern Indiana, northern Illinois (except the extreme northeast corner), and Iowa previously considered to be *myrina* have been found to be *nebraskensis*. There is intergradation with *atrocostalis* along the entire northern limit of the range of *myrina*, and some evidence of intergrading with *nebraskensis* to the south in Illinois and northeastern Nebraska.

Two aberrations of *myrina* have been given names. *Ab. nubes* (Scudder) was described from a male collected in Sanbornton, New Hampshire, in which the median spots were enlarged and somewhat suffused. The type is now in the Museum of Comparative Zoology at Harvard. The name *nivea* (Gunder) was given to an albino male collected May 28, 1900, on Staten Island, New York. The ground color, both dorsal and ventral, is white, with no maculation change. The type is in the American Museum of Natural History.

The type locality of *marilandica* (Clark) is Beltsville, Maryland, "From the boggy pasture on the south side of the road from the Beltsville, Md. railway station to the Dept. of Agriculture experiment farm." It is illustrated in Clark (1932, plate 3, figs. 5 & 6). The distinctive features listed in the original description were larger size, richer color, and heavier dark markings. There are no real consistent or significant differences between this local form (probably now extinct) and *myrina*, and it is here considered a synonym of *myrina*. The type is in the U.S. National Museum.

Records. The following records represent 193 typical specimens (130 ♂, 63 ♀) of *myrina* and additional intergrades examined:

myrina

CONNECTICUT: Fairfield, Hartford, and Windham cos. DELAWARE: Water Gap. MARYLAND: Baltimore and Garrett cos. MASSACHUSETTS: Hampshire and Norfolk cos. MICHIGAN: Indian Lake; Empire; Ramona; Cass, Delta, Jackson, Oakland, Ottawa, Van Buren, and Washtenaw cos. NEW JERSEY: Jamestown; Bergen, Hunterdon, Middlesex, Monmouth, Passaic, and Union cos. NEW YORK: Feurabush; E. Berne; Flushing; Ravenwood; McLean; New York City; Big Island; Somers; Fulton Co. PENNSYLVANIA: Lackawanna, Perry, and Schuylkill cos. RHODE ISLAND: Oak Lawn; Providence Co. SOUTH DAKOTA: Brown and Day cos. WISCONSIN: Dousman; Milwaukee; Brown, Milwaukee, Ozaukee, Walworth, Washington, and Waukesha cos.

nr. *myrina*

ILLINOIS: McHenry Co. MASSACHUSETTS: Mt. Greylock; Readville; Berkshire Co. MICHIGAN: Presque Isle Co. VERMONT: Bennington Co. WISCONSIN: Waupaca Co.

Boloria selene nebraskensis (Holland)

(Figs. 2, 6)

Brenthis myrina var. *nebraskensis* Holland, 1928, p. 36; 1931, p. 105, pl. LV, fig. 8 (male type).

Brenthis myrina race *nebraskensis*: Leussler, 1938, p. 216.

Brenthis myrina nebraskensis: McDunnough, 1938, p. 16.

Brenthis selene nebraskensis: Clark, 1941, p. 384.

Boloria selene nebraskensis: Klots, 1951, p. 89. Brown, 1957, p. 64. dos Passos, 1964, p. 89. Shepard (*in Howe*), 1975, p. 246.

Boloria selene nebrascensis: Forbes, 1960, p. 160.

Diagnosis. Series of *nebraskensis* can be separated quite easily from the other subspecies of *selene* on the basis of large size alone, although other distinct features are present (Tables 1 & 2).

The dorsal wing margins of *nebraskensis* have the least amount of black of any of the subspecies, and the basal areas of both wings dorsally also have the least suffusion of dark scales. The basal spot in the discal cell of the dorsal HW is seldom completely obscured by dark scales (only 6% of the 398 specimens examined). The black median lunules in cells M_2 , M_3 , and Cu_1 of the ventral FW are oblate and elongated as in *myrina*, but in *nebraskensis* this tendency is more pronounced.

Male. Dorsal surface: ground color bright orange; normal pattern of dark markings very sharply demarcated; black margins of both wings reduced, and enclosed row of orange marginal spots very distinct, large, and visible along entire margin; very little suffusion of black scales at wing bases; basal spot in discal cell of HW almost never obscured by dark scales; postbasal spot in discal cell of HW relatively small, leaving space equal to at least one-half diameter of spot between spot and veins Rs and M_3 above and below cell.

Ventral surface: ground color of FW very bright orange and usually extending completely to apical patch; apical patch bright cinnamon-brown, usually with little infusion of yellow scales; black median lunules in cells M_2 , M_3 , and Cu_1 of FW strongly oblate; slight dusting of yellow scales on cinnamon-brown ground color of HW in basal and limbal areas (postmedian band); postmedian row of light spots of HW all prominent and well silvered; anvil-shaped silver submedian spot in cell Cu_2 of HW almost never divided.

Length of forewing: 24.78 mm average.

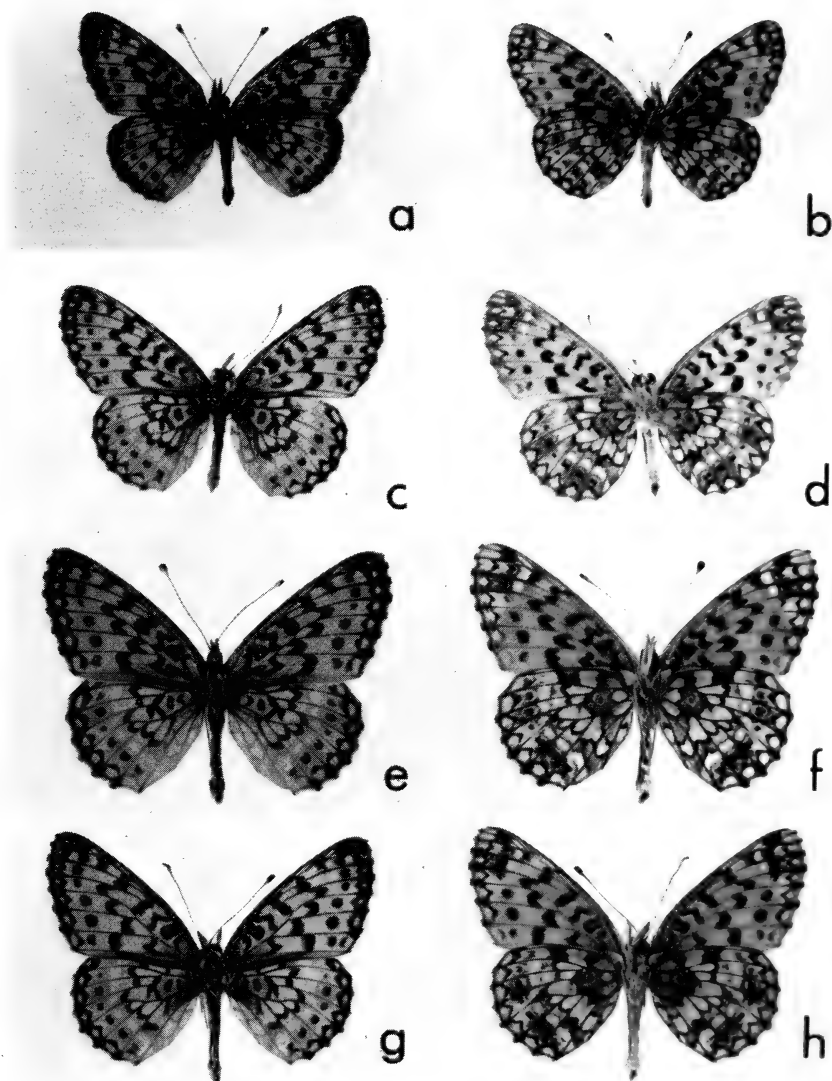


Fig. 2. Adults of *B. selene*: (a) *myrina* male, Schuylkill Haven, Schuylkill Co., Pa.; (b) same, ventral; (c) *myrina* male, New York City, N.Y.; (d) same, ventral; (e) *nebraskensis* male, Valley, Douglas Co., Neb.; (f) same, ventral; (g) *nebraskensis* male, Goose Lake Prairie State Park, Grundy Co., Ill.; (h) same, ventral. All photos natural size.

Female. Similar to male except orange of dorsal ground color slightly more pale. Length of forewing: 25.73 mm average.

Type locality. The type series consisted of four male specimens collected by Mr. E. A. Dodge. These specimens are presently at the Carnegie Museum in Pittsburgh. The type locality is Dodge Co., Nebraska.

Distribution. The range of *nebraskensis* is much more extensive than previous authors have reported. Typical specimens occur from east central Nebraska east through northern Iowa, northern Illinois, and northern Indiana to central Ohio (Fig. 1). It intergrades with *myrina* in some areas of the northern part of its range.

Remarks. *B. s. nebraskensis* was described by Holland in 1928 as a new variety of *B. myrina*. The sole basis for the name was the exceptional size of four male specimens collected by Mr. E. A. Dodge in Dodge Co., Nebraska. No description was given, except to call attention to size. Holland (1931) later discussed briefly *nebraskensis* in the revised edition of *The Butterfly Book* and illustrated a male type on Plate LV. Again, the only distinguishing character mentioned in the text was the large size.

My interest in *nebraskensis* was stimulated by discussion with Mr. Orville D. Spencer of Lincoln, Nebraska in 1968. Of particular interest was the fact that although good series of large typical specimens from Nebraska were present in some museums, none had been collected in recent years (Johnson, 1972).

I began actively seeking colonies of *nebraskensis* in Nebraska in the summer of 1968. That year colonies were located at Dead Timber State Recreation Area, Dodge Co., and Valley, Douglas Co. In 1969, several females taken from the Valley colony in July were kept alive and ova obtained. From these ova, 231 adult specimens (115 ♂, 116 ♀) were reared. Unfortunately, data on the immature stages were not kept, nor were photographs taken of the stages, nor were the stages studied in detail. The primary purpose of rearing was to obtain adult specimens.

In Nebraska, *nebraskensis* appears to have three broods per year; the first at the beginning of June from overwintering larvae, the second in mid-July, and the third in mid-August. Habitat where recent *nebraskensis* specimens were collected at Valley was wet meadow associated with river bottom and willow. Illinois habitats are similar (Conway, in litt.).

Records. Typical specimens of *nebraskensis* examined, including the reared Valley series, numbered 232 ♂ and 166 ♀. These records and additional intergrades are as follows:

nebraskensis

ILLINOIS: Chicago; Cook, Grundy, LaSalle, Mercer, and Stephenson cos. INDIANA: La Porte Co. IOWA: Winneshiek Co. NEBRASKA: Douglas Co. OHIO: Franklin, Medina, and Richland cos. SOUTH DAKOTA: Brookings Co.

myrina/nebraskensis

NEBRASKA: Dodge and Madison cos.

In the western panhandle of Nebraska, extreme western South Dakota, southwestern North Dakota, and the northeastern prairie region of Colorado, specimens of *selene* exhibit characters which are different from *nebraskensis*. This area is isolated geographically and includes the major remaining conifer forest and montane areas of the Great Plains. Because of this geographic isolation and the differences observed in specimens from this area, the following new subspecies of *B. selene* is described.

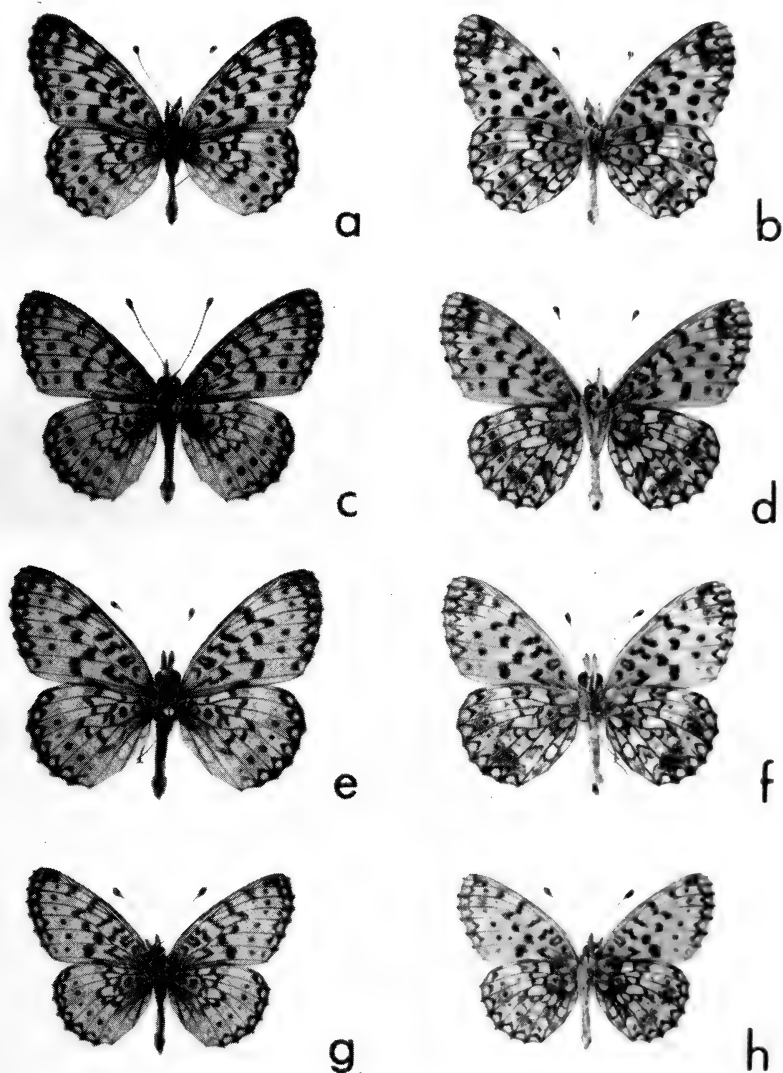


Fig. 3. Adults of *B. selene*: (a) *sabulocollis* male, holotype, Smith Lake, Sheridan Co., Neb.; (b) same, ventral; (c) *sabulocollis* male, paratype, Timnath, Larimer Co., Colo.; (d) same, ventral; (e) *sabulocollis* male, paratype, Mineral Springs, Slope Co., N.Dak.; (f) same, ventral; (g) *tollandensis* male, Tolland, Gilpin Co., Colo.; (h) same, ventral. All photos natural size.

***Boloria selene sabulocollis* Kohler new subspecies**

(Figs. 3, 6, 7)

Diagnosis. This subspecies is intermediate in size between *myrina* and *nebraskensis*. The main characters separating it from *nebraskensis* and *myrina*, which it is quite similar to dorsally, are on the ventral wing surfaces. The median black lunules in cells M_3 and Cu_1 of the ventral FW are "square-shaped," not oblate and elongated as in *myrina* and *nebraskensis*. There is more dusting of yellow scales on the cinnamon-brown ground color of the ventral HW of *sabulocollis*.

Male. Dorsal surface: normal pattern of dark markings sharply demarcated on orange ground color; row of orange marginal spots enclosed in black marginal band distinct and visible along entire margin of both wings, some suffusion of dark scales at wing bases, but basal spot in discal cell of HW seldom obscured; postbasal spot in discal cell of HW relatively small, leaving space equal to at least one-half diameter of spot between edge of spot and veins R_s above and M_3 below discal cell.

Ventral surface: ground color of FW dull orange, fading to yellow-orange before reaching apical patch; cinnamon-brown of apical patch dusted with yellow scales; black median lunules in cells M_3 and Cu_1 of FW "square-shaped," not oblate and elongated; considerable dusting and infusion of yellow scales in cinnamon-brown ground color of HW, with row of black spots in postmedian cinnamon-brown band surrounded by halos of yellow scales, and infusion of yellow scales in basal area of all cells; anvil-shaped silver submedian spot in cell Cu_2 of HW almost never divided.

Length of forewing: 22.82 mm average; holotype 22 mm.

Female. Similar to male, but with orange of dorsal ground color slightly more pale.

Length of forewing: 23.75 mm average; allotype 25 mm.

Types. Holotype: male, Smith Lake, Sheridan Co., Nebraska, 1.viii.68, S. Kohler; placed in the collection of the American Museum of Natural History.

Allotype: female, same data as holotype; placed in the collection of the American Museum of Natural History.

Paratypes (57): NEBRASKA: Smith Lake, Sheridan Co., 1.viii.68, S. Kohler, 22 ♂, 1 ♀; Dewey Lake, Cherry Co., 15.vii.69, S. Kohler, 1 ♂; Clear Lake, Cherry Co., 13.vi.29, 2 ♂; North Platte, Lincoln Co., 7.vii.29, 4 ♂, 2 ♀. SOUTH DAKOTA: S. of Lead, Hwy. 229, 5800', Lawrence Co., 10.vii.66, J. S. Nordin, 1 ♂; Ditch Cr., S. of Deerfield Res., Pennington Co., 19.vii.70, J. S. Nordin, 2 ♂; Custer State Park, 5000', Custer Co., 31.vii.64, J. S. Nordin, 2 ♂. NORTH DAKOTA: Mineral Springs, Slope Co., 20.vi.61, 23.vi.60, 10.vii.60, J. Oberfoell, 12 ♂, 1 ♀. COLORADO: Timnath, Larimer Co., 18.vii.72, R. E. Stanford, 2 ♂, 1 ♀; nr. Timnath, 4865', Larimer Co., 7.vi.73, R. E. Stanford, 2 ♂; nr. Timnath, Larimer Co., ex. ova 18.vii.72, em. 3-8.ix.72, R. E. Stanford, 1 ♂, 1 ♀.

Paratypes will be placed in the collections of the American Museum of Natural History, the Los Angeles County Museum, the National Museum of Natural History, the Allyn Museum of Entomology, J. S. Nordin, J. Oberfoell, J. R. Heitzman, R. E. Stanford, M. S. Fisher, and S. Kohler.

Distribution. The range of *sabulocollis* is limited to western Nebraska, the prairie region of northeastern Colorado, western South Dakota, and extreme southwestern North Dakota (Fig. 1). Specimens from Albany Co., Wyoming show intergradation between *sabulocollis* and *tollandensis*.

Remarks. A knowledge of the paleobotany of the western Great Plains is important in understanding how *sabulocollis* may have become isolated. Johnson (1975, 1976) points out that the present coniferous forests of the western Great Plains (Black Hills, Pine Ridge, Cheyenne Ridge, etc.) are the remains of extensive forest areas that once covered much of the region. The subspecies *sabulocollis* probably represents a relict of more extensive populations that were associated with the former coniferous forest.

Colonies in western Nebraska are situated at the marshy edges of lakes and adjacent wet meadows in the sandhills region, an area characterized by thousands of square miles of large, stabilized sand dunes covered with range grasses. The western part of this region, once covered by open pine-juniper forest, has abundant ground water, with many small lakes. Further east, the region becomes drier. The sandhills probably are an effective barrier to intergradation with *nebraskensis* to the east, although this possibility exists along the Platte and Elkhorn rivers. The colonies in southwestern North Dakota and western South Dakota are isolated from the east by extensive arid areas lacking suitable habitat.

The name *sabulocollis* is a combination of the Latin words for sand (*sabulo*) and hill (*collis*), which is descriptive of the area of the type locality.

Boloria selene tollandensis (Barnes & Benjamin)

(Figs. 3, 4, 7)

Brenthis myrina tollandensis Barnes & Benjamin, 1925, p. 44. Holland, 1928, p. 37. Klots, 1937, p. 328. McDunnough, 1938, p. 16.

Brenthis myrina var. *tollandensis*: Holland, 1931, p. 106.

Brenthis selene tollandensis: Clark, 1941, p. 384.

Boloria selene tollandensis: Remington, 1952, p. 67. Brown, 1957, p. 64. Albright, 1960, p. 158. Newcomer & Rogers, 1963, p. 171. dos Passos, 1964, p. 89. Shepard (in Howe), 1975, p. 246.

Boloria myrina (= *selene*) *tollandensis*: Brown, 1954, p. 64.

Diagnosis. This is the most lightly marked of the subspecies, with the pattern of dark maculation reduced dorsally, especially on the HW. Suffusion of dark scales in the basal areas of the wings dorsally is comparable to *atrocostalis*, and the basal spot in the discal cell of the dorsal HW is usually obscured by dark scaling. The postbasal spot in the discal cell of the dorsal HW is characteristically very large in relation to the cell, often filling almost the entire width of the cell. The size of this spot is accentuated by the otherwise fine maculation of the HW. Ventrally, *tollandensis* exhibits extensive infusion of yellow into the cinnamon-brown basal and discal areas of the HW.

Male. Dorsal surface: Ground color orange to yellow-orange; black marginal band reduced, and enclosed orange marginal spots very distinct and visible along entire margin of both wings; normal pattern of black markings reduced and narrow on both FW and HW, with exception of postbasal spot in discal cell of HW, which is enlarged and often fills almost entire width of cell, accentuated by otherwise fine markings of HW; considerable suffusion of dark scales at wing bases, especially on HW where dark scales form rather abrupt line across middle of discal cell, usually obscuring basal spot in cell.

Ventral surface: ground color of FW yellow-orange; apical cinnamon-brown patch of FW much reduced and powdery, with brown areas largely replaced by clear yellow-buff; black median lunules in cells M_3 and Cu_1 of FW "square shaped," not oblate; extensive yellow scaling in HW, with cinnamon-brown of postmedian band between postmedian and submarginal rows of silver spots reduced to powdery patches between veins R_s and M_2 and between veins M_3 and Cu_2 , and remaining brown of basal area of HW powdered with yellow scales; anvil-shaped silver submedian spot in cell Cu_2 of HW frequently divided (30% of specimens).

Length of forewing: 19.55 mm average.

Female. Similar to male but with orange of dorsal ground color noticeably more pale, especially on outer half of both FW and HW.

Length of forewing: 20.46 mm average.

Type locality. The type locality of *tollandensis* is Tolland, Gilpin Co. (not Moffat), Colorado. The original description (Barnes & Benjamin, 1925) lists Tol-

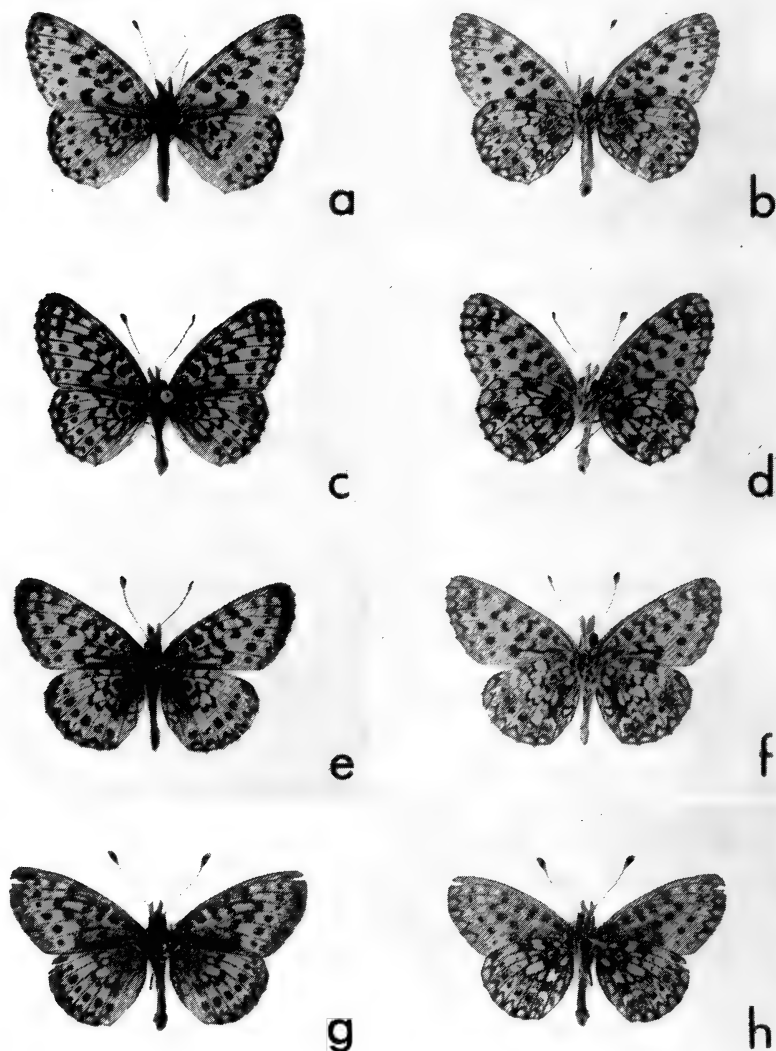


Fig. 4. Adults of *B. selene*: (a) *tollandensis* male, Avon, Cache Co., Ut.; (b) same, ventral; (c) *tollandensis/albequina* male, Moxee Bog, Yakima Co., Wash.; (d) same, ventral; (e) *tollandensis/albequina* male, Atlin, B.C.; (f) same, ventral; (g) *albequina* male, Homer, Alaska; (h) same, ventral. All photos natural size.

land as being in Moffat Co. This must be an error. The type series consisted of the holotype (♂), allotype (♀), and 12 paratypes (5 ♂, 7 ♀). All of these were in the Barnes collection, now at the U.S. National Museum.

Distribution. The range of typical *tollandensis* extends from north-central New

Mexico north through central Colorado and Wyoming, west through northeastern Utah, southern Idaho, and extreme southwestern Montana, and north through most of the Idaho panhandle.

Remarks. Nearly typical specimens have been examined from extreme northern Idaho. In eastern Oregon and Washington, and most of British Columbia, *tollandensis* intergrades with *albequina* (Holland) (Figs. 4 and 8). Intergrading with the eastern *atrocostalis* occurs over a wide band including most of Alberta and Montana, the eastern Idaho panhandle, and the northwest corner of Wyoming. Intergrading with *sabulocollis* occurs in eastern Wyoming.

Brown (1957) states that *tollandensis* in Colorado is single-brooded. Utah *tollandensis* appears to be double-brooded, and there is evidence that intergrades from Montana have two broods per year, since fresh adults have been collected from the same locality in both mid-June and mid-August.

Habitat listed by both Brown (1957) and Ferris (1971) for *tollandensis* in Colorado and Wyoming is willow bogs at rather high altitude, 9,000 to 10,000' for Colorado. The Utah specimens illustrated in Fig. 4 were taken at ca. 5500' elevation in an open boggy pasture near the mouth of a canyon. Montana specimens have been taken as low as 3300' in wet open meadows and river bottom near Missoula and at higher elevations in Glacier National Park and elsewhere in the state.

The aberration "*serratimarginata*" (Gunder) was described in 1926 from Vernon, British Columbia. The specimen, a male, was taken 12 August, 1904. The submarginal row of black markings of the dorsal HW are fused with the black marginal band, giving the margin a serrated appearance. The type is in the American Museum of Natural History (dos Passos, 1938).

Records. One hundred forty-one typical specimens (88 ♂, 53 ♀) of *tollandensis* and additional intergrades were examined. Records of these specimens are as follows:

tollandensis

COLORADO: Rocky Mtn. Nat. Park; nr. Northgate; Boulder, Conejos, Gilpin, Grand, Lake, Routt, and Summit cos. IDAHO: Blaine, Fremont, and Latah cos. MONTANA: Beaverhead Co. NEW MEXICO: Rio Arriba and Sandoval cos. UTAH: Vineyard; Cache, and Utah cos. WYOMING: NE of Cora; Fremont, Johnson, and Sublette cos.

nr. tollandensis

IDAHO: Bonner and Custer cos. OREGON: Crook Co. WYOMING: Big Horn Mts.; Albany, Carbon, and Teton cos.

albequina/tollandensis

BRITISH COLUMBIA: Beaverfoot Range; Smithers; Atlin; Fernie; Lillooet; Robson; Cranbrook; and Laird Hot Springs. WASHINGTON: Yakima Co.

atrocostalis/tollandensis

ALBERTA: Didsbury; Banff; Carbon; Pine Creek; Bilby; and Slave Lake. MONTANA: Cascade, Flathead, Gallatin, Granite, Jefferson, Lake, Missoula, Ravalli, and Sweet Grass cos. WYOMING: Yellowstone Nat. Park; Park and Teton cos.

Boloria selene albequina (Holland)

(Fig. 4)

Brenthis albequina Holland, 1928, p. 40, figs. 4, 5, and 6; 1931, p. 107, pl. LV, figs. 19, 20, and 21 (types). McDunnough, 1932, p. 269; 1938, p. 16 (as synonym of *atrocostalis*).

Brenthis albequina var. *baxteri* Holland, 1928, p. 42.

Brenthis myrina atrocotalis ab. *baxteri*: McDunnough, 1938, p. 16.

Boloria selene albequina: dos Passos, 1964, p. 89.

Boloria selene albequina ab. *baxteri*: dos Passos, 1964, p. 89.

Diagnosis. Dorsally, *albequina* is similar to *atrocostalis*. Both have heavy dark wing margins, but *albequina* differs from *atrocostalis* in having a greater suffusion of dark scales in the basal areas of the wings (Table 1). There is also a tendency for the pattern of dark spots which are not obscured by the dark basal suffusion to appear "blurred" or "smudged," not sharply demarcated as in *atrocostalis*.

The ventral surface of the HW of *albequina* also differs from that of *atrocostalis* in having considerable infusion of yellow scales into the cinnamon-brown of the basal and discal portions, as does *tollandensis*. In *atrocostalis*, these areas are largely solid cinnamon-brown.

Male. Dorsal surface: ground color of both wings dull orange; black marginal band heavy, and enclosed orange marginal spots obliterated on FW from apex posterior at least to cell M_3 , and remaining spots on FW and HW reduced to small orange points; normal pattern of black markings heavy and usually appearing slightly "blurred" or "smudged," not sharply demarcated; extensive suffusion of black scales into basal portions of wings, always obscuring basal spot in discal cell of HW and often postbasal spot, with suffusion forming more or less solid black patch on HW.

Ventral surface: ground color of FW dull yellow-orange; apical cinnamon-brown patch of FW much reduced and powdered with yellow scales, surrounded by dull yellow-buff; black median lunules in cells M_3 and Cu_1 of FW "square-shaped," not oblate; considerable yellow scaling on HW, with cinnamon-brown of postmedian band between postmedian and submarginal rows of silver spots reduced and powdered; silver spot of postmedian band in cell M_2 of HW lacking, and spot in cell M_3 often indistinct; anvil-shaped silver submedian spot in cell Cu_2 of HW frequently divided (39% of specimens).

Length of forewing: 19.17 mm average.

Female. Similar to male.

Length of forewing: 20.08 mm average.

Type locality. This subspecies was described from seven males collected at White Horse Pass, Yukon Territory, by W. F. O. Baxter. The types are in the Carnegie Museum.

Distribution. The range of typical *albequina* is limited to southwest Alaska and adjacent portions of the Yukon Territory east into the far west portion of the Northwest Territories (Fig. 1).

Remarks. In northern British Columbia, *albequina* intergrades with *tollandensis*. Many British Columbia specimens have been incorrectly referred to as *albequina*. Specimens from Alberta, Montana, and northwestern Wyoming, many of which were also previously referred to as *albequina*, represent a wide band of intergradation between *tollandensis* and *atrocostalis*. These specimens exhibit dark wing margins dorsally, as in *atrocostalis*, but the pattern of markings is reduced as in *tollandensis*, especially on the HW. In addition, the postbasal spot in the discal cell is often enlarged, covering nearly the width of the cell in many specimens, as it does in *tollandensis*. Ventrally, the HW of these specimens exhibits characteristics of both *tollandensis* and *atrocostalis* (Figs. 5 and 8).

It has been suggested by some authors, as early as 1932 (McDunnough) and as recently as 1975 (Shepard, in Howe), that the name *albequina* be reduced to the synonymy of *atrocostalis*. It is my opinion that this decision is based primarily on the study of specimens from zones of intergradation with *atrocostalis* and *tollandensis* and that the name *albequina* should be used for the Alaska, Yukon, and Northwest Territories populations.

In the original description of *albequina*, Holland (1928) placed considerable emphasis on the anvil-shaped silver submedian spot in cell Cu_2 of the ventral HW.

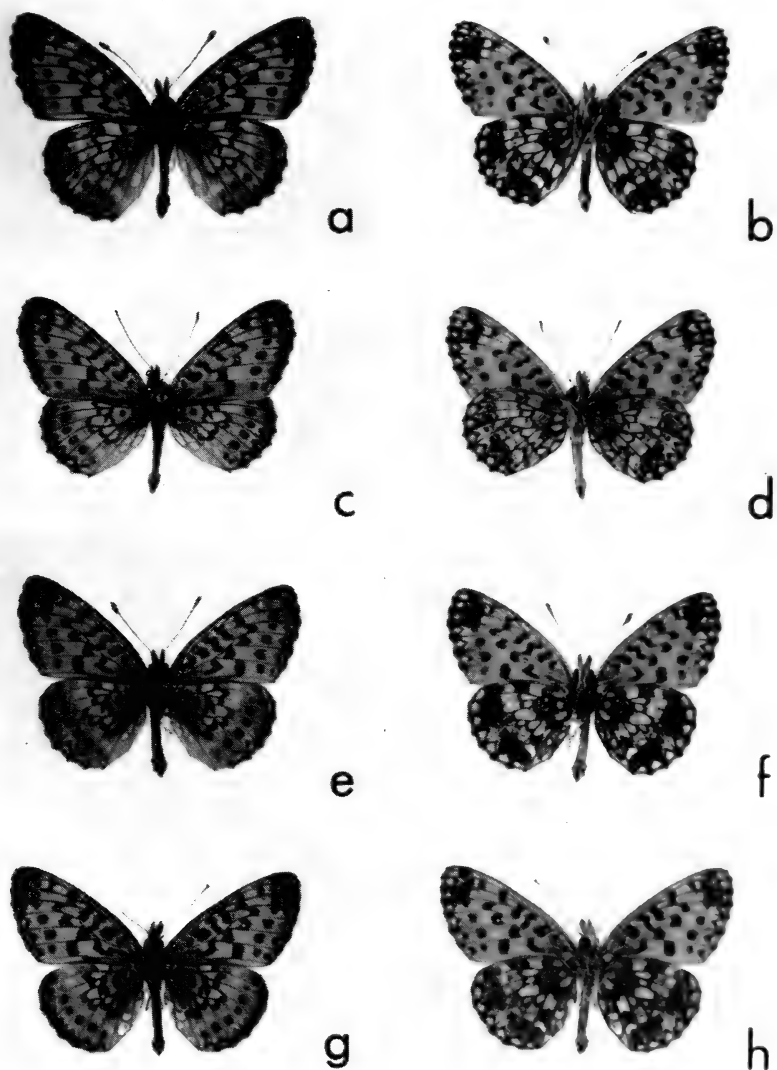


Fig. 5. Adults of *B. selene*: (a) *atrocostalis* male, Lake Jacques Cartier, Laurentides Park, Que.; (b) same, ventral; (c) *atrocostalis/tollandensis* male, Florence, Ravalli Co., Mont.; (d) same, ventral; (e) *terraenovae* male, Doyle's Station, Newfoundland; (f) same, ventral; (g) *terraenovae* male, Doyle's Station, Newfoundland; (h) same, ventral. All photos natural size.

He pointed out the tendency of this spot to be divided in *albequina* and the inner half reduced in size. McDunnough (1932) felt that many of the other differences mentioned by Holland were due to the rubbed condition of the specimens and that the stress Holland placed on the division of the silver spot was unwarranted, since this condition was also present in specimens of *atrocostalis* from the north shore of the Gulf of St. Lawrence. Of 239 typical specimens of *atrocostalis* examined in this study, only 6% showed division of the submedian silver spot in cell Cu_2 of the ventral HW. This compares with the division of this spot being displayed in 39% of the specimens of *albequina* examined. Of 141 typical specimens of *tollandensis* examined, 30% had this spot divided. The tendency for the spot to be divided in both *albequina* and *tollandensis* and the extensive yellow scaling of the HW of both show that *albequina* is more closely allied to *tollandensis* than *atrocostalis*.

The name *baxteri* was given by Holland (1928) to an aberrant female of the same series as the types of *albequina* from White Horse Pass, Yukon Territory. The dark basal and median markings of the dorsal wing surfaces are enlarged and connected on this aberration.

Records. A total of 21 typical specimens (15 ♂, 6 ♀) of *albequina* were examined. This included a series that was examined for me by Mr. Kenelm Philip, Alaska Institute of Arctic Biology. The records are as follows:

albequina

ALASKA: Kenai Peninsula; Kodiak; Goldstream Valley, nr. Fairbanks; Chatanika River, NE of Fairbanks; nr. Talkeetna; and mile 154.7, new Anchorage-Fairbanks Hwy.

nr. *albequina*

ALBERTA: Laggan (Lake Louise).

Boloria selene atrocostalis (Huard)

(Figs. 5, 8)

Argynnis atrocostalis (Provancher and) Huard, 1926 (1927), p. 131.

Brenthis myrina atrocostalis: McDunnough, 1930, p. 107; 1938, p. 16. dos Passos & Grey, 1934, p. 190.

Brenthis myrina ab. *jenningsae* Holland, 1928, p. 36.

Brenthis myrina var. *jenningsae*: Holland, 1931, p. 105, pl. LVI, fig. 9 (male type).

Brenthis myrina atrocostalis ab. *jenningsae*: McDunnough, 1932, p. 269; 1938, p. 16.

Boloria selene atrocostalis ab. *jenningsae*: dos Passos, 1964, p. 89.

Brenthis selene atrocostalis: Clark, 1941, p. 384.

Boloria selene atrocostalis: Klots, 1951, p. 89. dos Passos, 1964, p. 89. Shepard (*in* Howe), 1975, p. 246.

Diagnosis. The subspecies *atrocostalis* is separated from *myrina* by the heavy dark marginal wing scaling dorsally, which often almost completely eliminates the normal row of orange marginal spots. It also has more suffusion of dark scales in the basal portions of the wings dorsally than does *myrina*, but not as much as *albequina*. Ventrally, the cinnamon-brown ground color of the HW of *atrocostalis* is not reduced or infused with yellow scales, as in *albequina*. The ventral FW median black lunules in cells M_3 and Cu_1 of *atrocostalis* are more "square-shaped," instead of oblate as in *myrina*.

Male. Dorsal surface: ground color bright orange; black marginal band heavy and broad, with enclosed orange marginal row of spots largely obscured by black, especially on FW, or completely obliterated by black on both FW and HW of

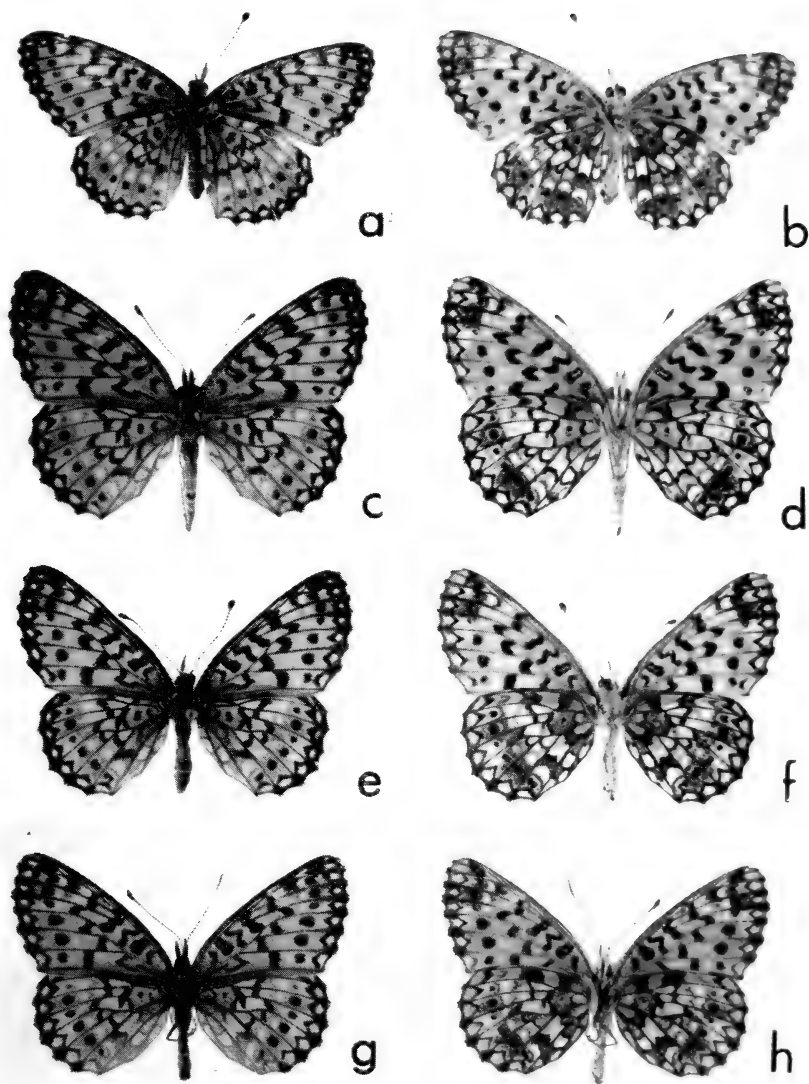


Fig. 6. Adults of *B. selene*: (a) *myrina* female, New York City, N.Y.; (b) same, ventral; (c) *nebraskensis* female, Valley, Douglas Co., Neb.; (d) same, ventral; (e) *nebraskensis* female, Goose Lake Prairie State Park, Grundy Co., Ill.; (f) same, ventral; (g) *sabulocollis* female allotype, Smith Lake, Sheridan Co., Neb.; (h) same, ventral. All photos natural size.

some specimens; normal pattern of black markings heavier, but sharply outlined on orange ground color; some suffusion of dark scales at bases of both wings, extending distally near inner margin of FW to median row of spots, and on HW filling ca. one-half of discal cell; basal spot in discal cell of HW usually obscured by dark scales.

Ventral surface: ground color of FW dull orange, extending to apical patch with no fading; apical patch of FW large, and solid cinnamon-brown in color, with little or no powdering of yellow scales; black median lunules in cells M_3 and Cu_1 of FW "square-shaped," not oblate; cinnamon-brown ground color of HW in basal portion and in postmedian band between postmedian and submarginal rows of silver spots solid, with little or no infusion of yellow scales; all postmedian light spots of HW prominent and well silvered.

Length of forewing: 20.08 mm average.

Female. Similar to male except orange ground color of dorsal surface slightly more pale and black dorsal wing margins less broad and heavy, with orange marginal row of spots more conspicuous.

Length of forewing: 20.57 mm average.

Type locality. The type locality of *atrocostalis* is Chicoutimi, Quebec.

Distribution. The range of *atrocostalis* extends from Nova Scotia west through Canada to western Saskatchewan and as far north as Churchill and Lynn Lake, Manitoba. In the United States, *atrocostalis* is found in Maine, most of Vermont and New Hampshire, the northern portions of New York, Michigan, Wisconsin, Minnesota, and in eastern North Dakota (Fig. 1).

Remarks. Huard (*in* Provancher & Huard, 1926) used the name *atrocostalis* at the species rank, but shortly after, McDunnough (1928) examined the type and found that it represented what he considered to be the eastern Canadian form of *myrina*. McDunnough then applied the name at subspecies rank to eastern Canada specimens.

The subspecies *atrocostalis* intergrades with *tollandensis* in Alberta, Montana, and northwestern Wyoming, with *albequina* in the northwestern part of its range and *myrina* along much of the southern limit of its range.

The name *jenningsae* (Holland) was applied in 1928 to an aberrant male specimen taken by Mrs. O. E. Jennings at Jellicoe, on Thunder Bay, Ontario. The transverse markings of the wings are fused and enlarged. The type is in the Carnegie Museum.

Records. Two hundred thirty-nine typical specimens (159 ♂, 80 ♀) and additional intergrades were examined:

atrocostalis

MAINE: Rangeley; E. Haepswell; Gilead; Seboomook Lake; Androscoggin, Penobscot, and Piscataquis cos. MANITOBA: Bereton Lake; Kelwood; Red Rock Lake; Brokenhead; Churchill; Betula Lake; Rennie; McCreary; Telford; and Riding Mts. MICHIGAN: Cheboygan, Chippewa, Emmet, Ostego, and Schoolcraft cos. MINNESOTA: Arago; Aitkin, Anoka, Cass, Cook, Crow Wing, Dakota, Lake, Otter Tail, St. Louis, Sherburne, and Rice cos. NEW BRUNSWICK: Edmundston; St. Leonard; and Dorchester. NEW HAMPSHIRE: Randolph; Jefferson; Belknap, Carrol, Coos, and Grafton cos. ONTARIO: Nakina; Hymers; Savanne; Nipegon; Nipegon Lake; One Sided Lake; Upsala; Poland; Geraldton; Sudbury; Wabigoon; Guelph; Goodwood; Toronto; Charlton; and Blind River. QUEBEC: Montreal; Casapedia River; Lytton; Lanoriae; Laval; Lominique; Bois de Filion; Laurentides Park; St. Calixte de Kilkenny; Metapedia; Ste. Flavien; and St. Agapit. SASKATCHEWAN: Rivercourse and Lloydminster. VERMONT: Caledonia and Windsor cos. WISCONSIN: Chippewa, Dunn, Forest, Lincoln, Marathon, Oneida, Price, and Sawyer cos.

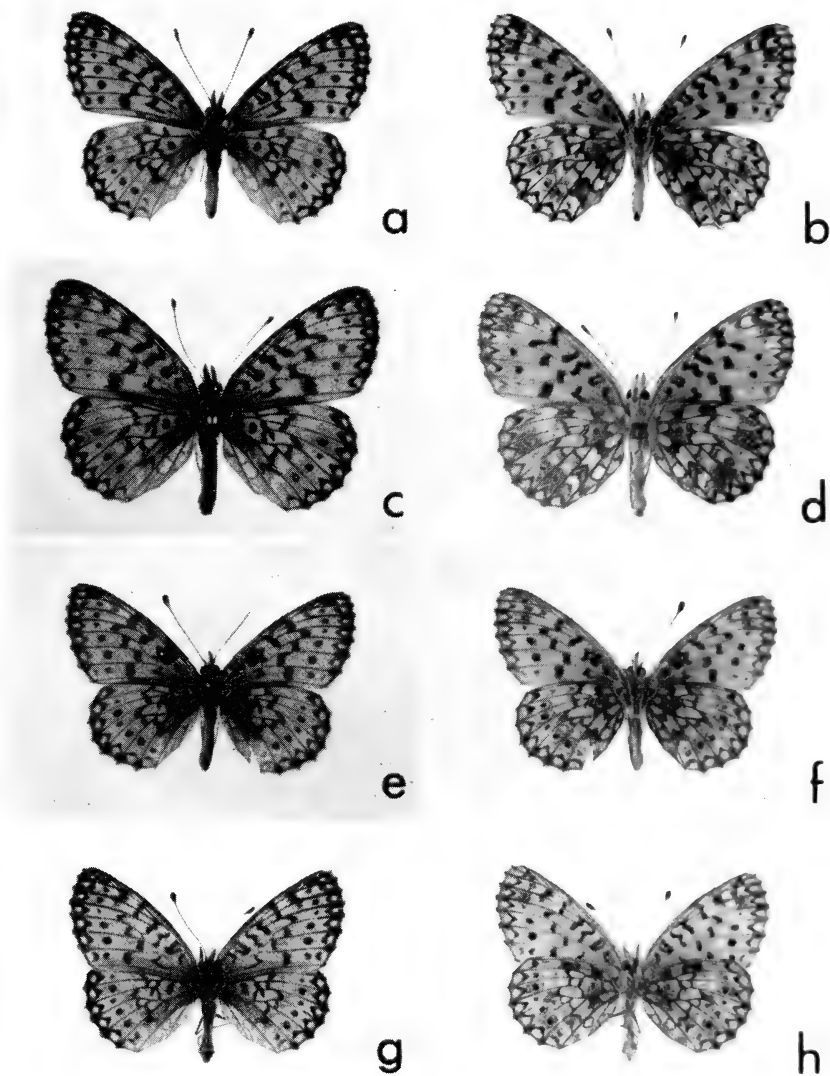


Fig. 7. Adults of *B. selene*: (a) *sabulocollis* female, paratype, Timnath, Larimer Co., Colo.; (b) same, ventral; (c) *sabulocollis* female paratype, Mineral Springs, Slope Co., N.Dak.; (d) same, ventral; (e) *tollandensis* female, Tolland, Gilpin Co., Colo.; (f) same, ventral; (g) *tollandensis* female, Avon, Cache Co., Ut.; (h) same, ventral. All photos natural size.

Boloria selene terraenovae (Holland)

(Fig. 5)

Brenthis myrina terrae-novae Holland, 1928, p. 36. dos Passos, 1935, p. 87. McDunnough, 1938, p. 16.

Brenthis myrina var. *terrae-novae*: Holland, 1931, p. 105, pl. LV, fig. 13 (male type).

Brenthis selene terrae-novae: Clark, 1941, p. 384.

Boloria selene terrae-novae: Klots, 1951, p. 89.

Boloria selene terraenovae: dos Passos, 1964, p. 89. Shepard (*in* Howe), 1975, p. 264.

Diagnosis. The dorsal wing surfaces of the majority of *terraenovae* specimens are much like *myrina*. The wing margins are not as heavily marked with black scales as are those of *atrocostalis*. Basal suffusion of dark scales is a bit heavier than in *myrina*, but few specimens approach the degree of suffusion in Holland's types.

The ventral surfaces of the HW are a different shade of brown, being consistently a deep, bright mahogany rather than the cinnamon-brown of the other subspecies. Occasionally, specimens of *atrocostalis* will approach this mahogany color of the HW, but have the heavier black wing margins characteristic of that subspecies.

Male. Dorsal surface: ground color bright red-orange; black marginal band not heavy, and enclosed orange marginal row of spots visible along entire margin of both wings in most specimens; normal pattern of black markings sharply demarcated on ground color; suffusion of dark scales in basal areas of both wings, in HW filling ca. one-half of discal cell; basal spot in discal cell of HW almost always obscured by dark scales.

Ventral surface: ground color of FW deep orange, usually extending to apical patch with little or no change in color; apical patch of FW not reduced, and solid bright mahogany-brown, with no powdering of yellow scales; ground color of HW uniform deep, bright mahogany, and solid, with little or no infusion of yellow scales; yellow areas of HW more or less restricted to cells R_s , M_1 , M_3 , and Cu_1 in area between submedian and postmedian rows of silver spots and to normal patch in cells M_2 and M_3 just basad of submarginal row of silver spots; row of black limbal spots on HW overlaid with mahogany scales, with mahogany color masking black so that spots appear dark brown; all postmedian silver spots prominent, except spot in cell M_2 , which is reduced in most specimens.

Length of forewing: 20.67 mm average.

Female. Similar to male, but orange of dorsal ground color more pale.

Length of forewing: 21.50 mm average.

Type locality. The type locality of *terraenovae* is listed only as Newfoundland. Mr. C. F. dos Passos (1935) examined the holotype and two paratypes and commented that, although the labels did not show from what area of Newfoundland they came, it was probably the eastern part of the island. The types are in the Carnegie Museum.

Distribution. The range of *terraenovae* is limited to the Island of Newfoundland.

Remarks. In Nova Scotia and possibly New Brunswick, *terraenovae* intergrades to some extent with *atrocostalis*. *Boloria selene* have been recorded from Labrador, and these may represent neither *terraenovae* nor *atrocostalis*, but too few specimens are available to make sound judgments.

In the original description by Holland (1928), the only distinguishing factor mentioned was that the inner halves of both wings were suffused dorsally by dark scales, obscuring the wing markings in these areas. Such specimens are not representative of the normal run of specimens from Newfoundland, as evidenced by the specimens examined for this study. In 1935, dos Passos reached similar conclusions

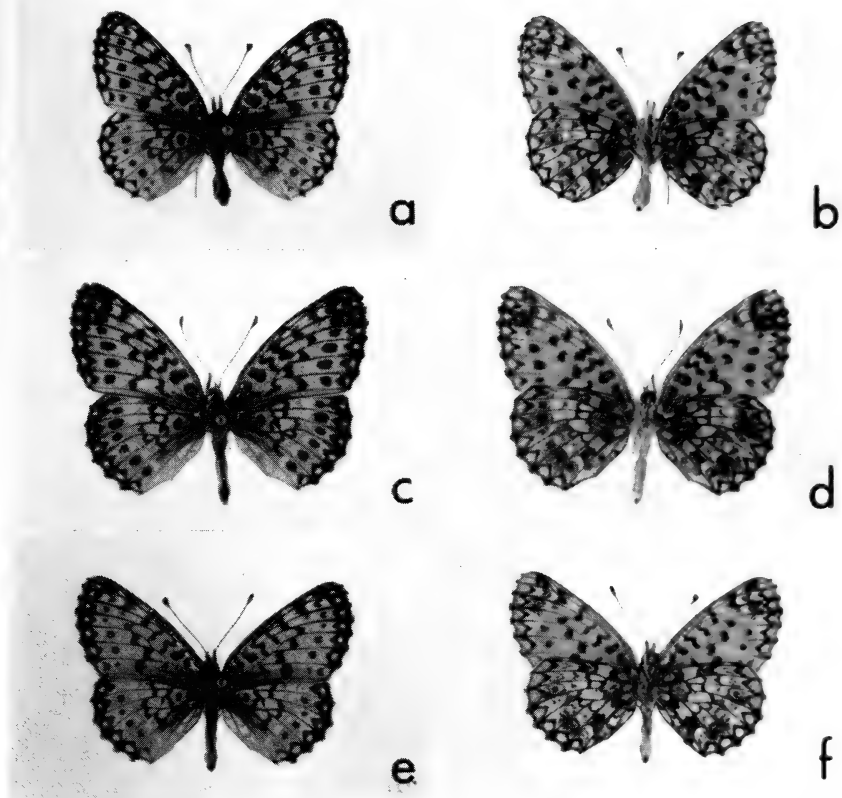


Fig. 8. Adults of *B. selene*: (a) *tollandensis/albequina* female, Moxee Bog, Yakima Co., Wash.; (b) same, ventral; (c) *atrocostalis* female, Lytton, Que.; (d) same, ventral; (e) *atrocostalis/tollandensis* female, Florence, Ravalli Co., Mont.; (f) same, ventral. All photos natural size.

when he examined a series of 32 males and 11 females from Newfoundland and compared them with the types. He found that some specimens were as heavily marked with dark scales in the basal wing areas but that most of the specimens were not.

Records. Fifteen typical specimens (14 ♂, 1 ♀) of *terraenovae* were studied. These records and additional intergrades are as follows:

terraenovae

NEWFOUNDLAND: Doyle's Station; Codroy; and Spruce Brook.

nr. *terraenovae*

NOVA SCOTIA: Mt. Uniacke; Port Shoreham; and Passboro.

CONCLUSIONS

Although *Boloria selene* is quite variable in both size and markings, several recognizable and consistent populations exist within its range in North America. There is considerable intergradation among these populations at the limits of their ranges. Over the course of this study, the ranges of these recognizable populations have been more precisely defined, as have the zones of intergradation among populations.

In general, *selene* in North America exhibits a gradual intergradation of characters throughout its range, more evident on north-south lines, but also present on east-west lines. Names are available to apply at subspecific rank to populations sufficiently differentiated on these clines, and are useful tools when so applied. It is felt that the existence of these clines has not been obscured by the recognition of too many subspecies names and that those names recognized in this paper best portray the population changes on the clines.

In the west, typical *tollandensis* from the mountains of central Colorado and New Mexico form the southern pole of a cline and gradually intergrade into *albequina* in southwestern Alaska at the northern pole of the cline. A quite variable intermediate population occurs in a broad band including eastern Oregon and Washington, most of British Columbia, Alberta, northern Idaho and Montana, and northwestern Wyoming. This intermediate population is influenced by intergrading from the east, by *atrocostalis* on the north and *sabulocollis* to the south. Specimens from much of this intermediate population may show characteristics predominantly of *tollandensis*, *albequina*, or *atrocostalis*, or characteristics that are intermediate.

In the western Great Plains, a relict population (*sabulocollis*), which probably became isolated as coniferous forest began its demise in this area, has been newly described.

In the east, the north-south intergradation is more stepped and closely parallels environmental factors, chiefly habitat. The northern population (*atrocostalis*) of the coniferous boreal forest zone intergrades into the central population (*myrina*), associated with the deciduous eastern forest zone, and then into the southern population (*nebraskensis*) of the prairie zone, which has never supported forests.

On the east coast, the population named *marilandica* is a local phenotypic expression influenced by habitat similar to that of *nebraskensis*. The *marilandica* population is restricted to a prairie habitat of the lower coastal plain in Maryland, while *myrina* is present in the piedmont and deciduous forest zones. Because it is a local phenotypic population

differing only slightly from *myrina*, *marilandica* has been relegated to the synonymy of *myrina*.

A weaker east-west cline is formed by *terraenovae* and *atrocostalis* in the northeastern portion of the range of *selene*. The name *terraenovae* is retained to apply to the sufficiently differentiated eastern pole of this cline.

Through application of this gradual intergradation concept, ranges of some *selene* populations have been significantly expanded (*nebraskensis* and *tollandensis*), while others have been reduced (*albequina* and *myrina*).

As a result of this study, the following treatment of *Boloria selene* in North America is proposed:

Boloria selene (Denis & Schiffermüller), 1775

- a. *s. myrina* (Cramer), 1777
 - myrinus* (Herbst), 1798
 - myrissa* (Godart), 1819
 - ab. "nubes" (Scudder), 1889
 - ab. "nivea" (Gunder), 1928
 - marilandica* (Clark), 1941
- b. *s. nebraskensis* (Holland), 1928
- c. *s. sabulocollis* Kohler, 1977
- d. *s. tollandensis* (Barnes & Benjamin), 1925
 - ab. "serratimarginata" (Gunder), 1926
- e. *s. albequina* (Holland), 1928
 - ab. "baxteri" (Holland), 1928
- f. *s. atrocostalis* (Huard), 1927
 - ab. "jenningsae" (Holland), 1928
- g. *s. terraenovae* (Holland), 1928

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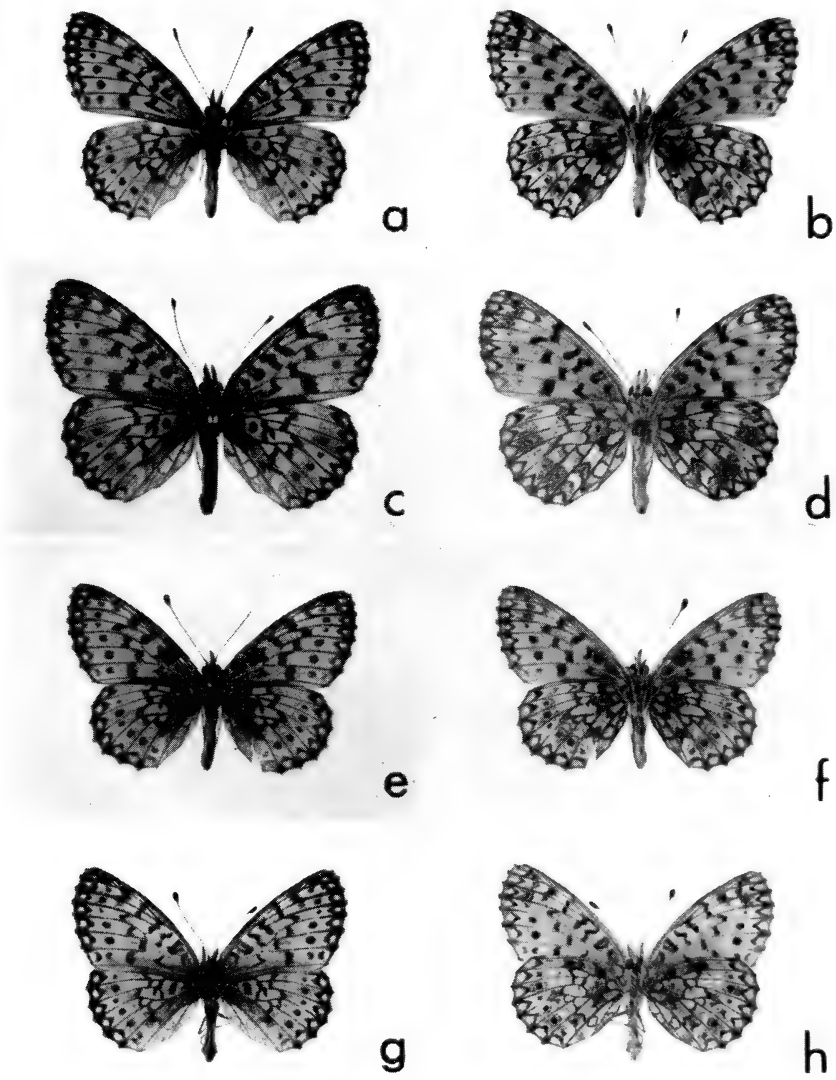


Fig. 7. Adults of *B. seleno*: (a) *sabulocollis* female, paratype, Timnath, Larimer Co., Colo.; (b) same, ventral; (c) *sabulocollis* female paratype, Mineral Springs, Slope Co., N.Dak.; (d) same, ventral; (e) *tollandensis* female, Tolland, Gilpin Co., Colo.; (f) same, ventral; (g) *tollandensis* female, Avon, Cache Co., Ut.; (h) same, ventral. All photos natural size.

Boloria selene terraenovae (Holland)

(Fig. 5)

Brenthis myrina terrae-novae Holland, 1928, p. 36. dos Passos, 1935, p. 87. McDunnough, 1938, p. 16.

Brenthis myrina var. *terrae-novae*: Holland, 1931, p. 105, pl. LV, fig. 13 (male type).

Brenthis selene terrae-novae: Clark, 1941, p. 384.

Boloria selene terrae-novae: Klots, 1951, p. 89.

Boloria selene terraenovae: dos Passos, 1964, p. 89. Shepard (*in* Howe), 1975, p. 264.

Diagnosis. The dorsal wing surfaces of the majority of *terraenovae* specimens are much like *myrina*. The wing margins are not as heavily marked with black scales as are those of *atrocostalis*. Basal suffusion of dark scales is a bit heavier than in *myrina*, but few specimens approach the degree of suffusion in Holland's types.

The ventral surfaces of the HW are a different shade of brown, being consistently a deep, bright mahogany rather than the cinnamon-brown of the other subspecies. Occasionally, specimens of *atrocostalis* will approach this mahogany color of the HW, but have the heavier black wing margins characteristic of that subspecies.

Male. Dorsal surface: ground color bright red-orange; black marginal band not heavy, and enclosed orange marginal row of spots visible along entire margin of both wings in most specimens; normal pattern of black markings sharply demarcated on ground color; suffusion of dark scales in basal areas of both wings, in HW filling ca. one-half of discal cell; basal spot in discal cell of HW almost always obscured by dark scales.

Ventral surface: ground color of FW deep orange, usually extending to apical patch with little or no change in color; apical patch of FW not reduced, and solid bright mahogany-brown, with no powdering of yellow scales; ground color of HW uniform deep, bright mahogany, and solid, with little or no infusion of yellow scales; yellow areas of HW more or less restricted to cells Rs, M₁, M₃, and Cu₁ in area between submedian and postmedian rows of silver spots and to normal patch in cells M₂ and M₃ just basad of submarginal row of silver spots; row of black limbal spots on HW overlaid with mahogany scales, with mahogany color masking black so that spots appear dark brown; all postmedian silver spots prominent, except spot in cell M₃, which is reduced in most specimens.

Length of forewing: 20.67 mm average.

Female. Similar to male, but orange of dorsal ground color more pale.

Length of forewing: 21.50 mm average.

Type locality. The type locality of *terraenovae* is listed only as Newfoundland. Mr. C. F. dos Passos (1935) examined the holotype and two paratypes and commented that, although the labels did not show from what area of Newfoundland they came, it was probably the eastern part of the island. The types are in the Carnegie Museum.

Distribution. The range of *terraenovae* is limited to the Island of Newfoundland.

Remarks. In Nova Scotia and possibly New Brunswick, *terraenovae* intergrades to some extent with *atrocostalis*. *Boloria selene* have been recorded from Labrador, and these may represent neither *terraenovae* nor *atrocostalis*, but too few specimens are available to make sound judgments.

In the original description by Holland (1928), the only distinguishing factor mentioned was that the inner halves of both wings were suffused dorsally by dark scales, obscuring the wing markings in these areas. Such specimens are not representative of the normal run of specimens from Newfoundland, as evidenced by the specimens examined for this study. In 1935, dos Passos reached similar conclusions

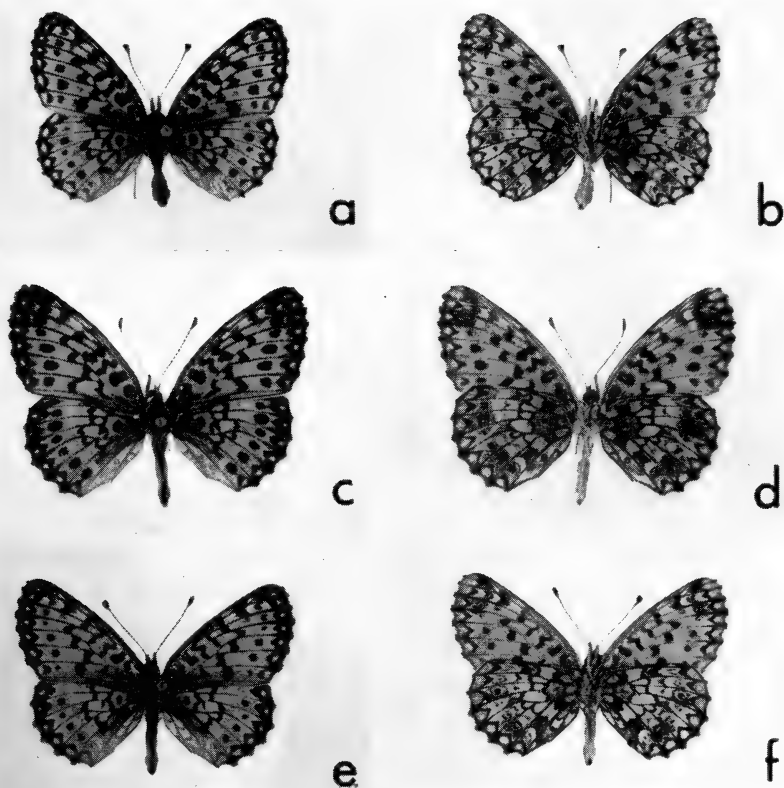


Fig. 8. Adults of *B. selene*: (a) *tollandensis/albequina* female, Moxee Bog, Yakima Co., Wash.; (b) same, ventral; (c) *atrocostalis* female, Lytton, Que.; (d) same, ventral; (e) *atrocostalis/tollandensis* female, Florence, Ravalli Co., Mont.; (f) same, ventral. All photos natural size.

when he examined a series of 32 males and 11 females from Newfoundland and compared them with the types. He found that some specimens were as heavily marked with dark scales in the basal wing areas but that most of the specimens were not.

Records. Fifteen typical specimens (14 ♂, 1 ♀) of *terraenovae* were studied. These records and additional intergrades are as follows:

terraenovae

NEWFOUNDLAND: Doyle's Station; Codroy; and Spruce Brook.

nr. *terraenovae*

NOVA SCOTIA: Mt. Uniacke; Port Shoreham; and Passboro.

CONCLUSIONS

Although *Boloria selene* is quite variable in both size and markings, several recognizable and consistent populations exist within its range in North America. There is considerable intergradation among these populations at the limits of their ranges. Over the course of this study, the ranges of these recognizable populations have been more precisely defined, as have the zones of intergradation among populations.

In general, *selene* in North America exhibits a gradual intergradation of characters throughout its range, more evident on north-south lines, but also present on east-west lines. Names are available to apply at subspecific rank to populations sufficiently differentiated on these clines, and are useful tools when so applied. It is felt that the existence of these clines has not been obscured by the recognition of too many subspecies names and that those names recognized in this paper best portray the population changes on the clines.

In the west, typical *tollandensis* from the mountains of central Colorado and New Mexico form the southern pole of a cline and gradually intergrade into *albequina* in southwestern Alaska at the northern pole of the cline. A quite variable intermediate population occurs in a broad band including eastern Oregon and Washington, most of British Columbia, Alberta, northern Idaho and Montana, and northwestern Wyoming. This intermediate population is influenced by intergrading from the east, by *atrocostalis* on the north and *sabulocollis* to the south. Specimens from much of this intermediate population may show characteristics predominantly of *tollandensis*, *albequina*, or *atrocostalis*, or characteristics that are intermediate.

In the western Great Plains, a relict population (*sabulocollis*), which probably became isolated as coniferous forest began its demise in this area, has been newly described.

In the east, the north-south intergradation is more stepped and closely parallels environmental factors, chiefly habitat. The northern population (*atrocostalis*) of the coniferous boreal forest zone intergrades into the central population (*myrina*), associated with the deciduous eastern forest zone, and then into the southern population (*nebraskensis*) of the prairie zone, which has never supported forests.

On the east coast, the population named *marilandica* is a local phenotypic expression influenced by habitat similar to that of *nebraskensis*. The *marilandica* population is restricted to a prairie habitat of the lower coastal plain in Maryland, while *myrina* is present in the piedmont and deciduous forest zones. Because it is a local phenotypic population

differing only slightly from *myrina*, *marilandica* has been relegated to the synonymy of *myrina*.

A weaker east-west cline is formed by *terraenovae* and *atrocostalis* in the northeastern portion of the range of *selene*. The name *terraenovae* is retained to apply to the sufficiently differentiated eastern pole of this cline.

Through application of this gradual intergradation concept, ranges of some *selene* populations have been significantly expanded (*nebraskensis* and *tollandensis*), while others have been reduced (*albequina* and *myrina*).

As a result of this study, the following treatment of *Boloria selene* in North America is proposed:

Boloria selene (Denis & Schiffermüller), 1775

- a. *s. myrina* (Cramer), 1777
 - myrinus* (Herbst), 1798
 - myrissa* (Godart), 1819
 - ab. "nubes" (Scudder), 1889
 - ab. "nivea" (Gunder), 1928
 - marilandica* (Clark), 1941
- b. *s. nebraskensis* (Holland), 1928
- c. *s. sabulocollis* Kohler, 1977
- d. *s. tollandensis* (Barnes & Benjamin), 1925
 - ab. "serratimarginata" (Gunder), 1926
- e. *s. albequina* (Holland), 1928
 - ab. "baxteri" (Holland), 1928
- f. *s. atrocostalis* (Huard), 1927
 - ab. "jenningsae" (Holland), 1928
- g. *s. terraenovae* (Holland), 1928

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entrance to the bait. Fermenting bananas served as bait every day except one when pineapple was placed with the banana. The bait was replaced every 2–3 days. The trap was suspended from the NW corner of the author's garage. The base of the trap was 1.3 m above ground level.

Cuts were made in the trunk of a gmelina (*Gmelina arborea*) to attract other *Charaxes*.

All *Charaxes* collected were caught on bright sunny days. Specimens were identified to species and those in good condition were stored in paper triangles. Sex of the specimens was not determined.

RESULTS

The following species and numbers were trapped using banana as bait. *Charaxes estesipe* (Godart): 3 September 1973, 15 November 1973, 17 November 1973, 23 April 1974; *Charaxes tiridates* (Cramer): 23 December 1973, 28 December 1973; *Charaxes boueti* Feisthamel: 11 December 1973, 9 January 1974, 21 January 1974, 24 April 1974; *Charaxes jaisius* Reiche: 16 December 1973, 18 December 1973, 29 December 1973, 9 January 1974, 19 April 1974; *Charaxes viola* Butler: 16 December 1973, 23 December 1973; *Charaxes castor* Cramer: 23 October 1973, 11 November 1973, 18 December 1973; *Charaxes brutus* Cramer: 6 August 1973, 30 September 1973; *Charaxes catachrous* Staudinger: 21 December 1973; *Charaxes achaemenes* Felder: 15 December 1973, 21 December 1973; *Charaxes lucretius* (Cramer): 25 December 1973, 6 January 1974; *Charaxes lactitinctus* Karsch: 24 April 1974.

Only one *Charaxes eupale* (Drury) was collected, on the day when the trap was baited with banana and pineapple. One *C. castor* was caught feeding on the sap from the *G. arborea*, and one *C. lactitinctus* was caught feeding on feces and urine (animal species unknown) on the Egede-Affa road.

DISCUSSION

The collection of *C. eupale* on the banana-pineapple combination is interesting but not significant. Owen & Chanter (1972, J. Ent. (A) 46: 135–143) reported numerous *C. eupale* attracted to banana bait in Sierra Leone. Boorman (1965, Nigerian butterflies. Part III: Nymphalidae-Section I, Ibadan Univ. Press, Ibadan, 16 p.) noted that *C. achaemenes* records are few from Nigeria, mainly from savannah areas north of Ibadan. The collection of *C. achaemenes* in Enugu will add to the recorded distribution of the species. *C. lactitinctus* is considered rare by Boorman (*Ibid.*). Nigerian records are mainly from the Enugu area. Collection of this species from a derived savannah and urban garden situation probably indicates a lack of intensive collection in similar areas of Nigeria.

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SUPPLEMENT TO "A CHECKLIST OF THE BUTTERFLIES OF
GRANT COUNTY, NEW MEXICO AND VICINITY"¹

Although drought conditions prevailed in the Southwest during much of the summer of 1976, some localities in the mountains north of Silver City, New Mexico received a moderate amount of moisture. The Burro Mountains and the high plateau areas such as L-S Mesa were very dry, but both Cherry Creek Canyon and the Mimbres River Valley supported fairly lush vegetation in July. On the east slope of the Black Range below Emory Pass, there was an especially good crop of wildflowers along Highway 90. Butterflies were abundant about these flowers for the first time in a number of years. Many species were taken that had not been seen in Grant and Sierra counties for at least five years.

In April 1976, the author published a checklist of the butterflies of the Grant Co., New Mexico region (J. Lepid. Soc. 30: 38-49). This paper reported the results of 10 years of collecting. Collecting in July 1976 produced three species new to the area and a number of range extensions. The purpose of this note is to update the checklist published earlier. The list for this region now stands at 160 confirmed species with several additional sight records. Additional locality data were obtained for 48 species.

The locality alphabetic codes are those used in the original checklist and shown in Figures 1 and 2 of that paper. One additional code, **MRV**, has been introduced. This applies to the Mimbres River Valley from San Lorenzo to just south of Sherman. The three new species entries are preceded by an asterisk.

As in the past, the author's cousin, Ralph A. Fisher, Jr. assisted him in the field and he is responsible for many of the Sierra Co. records.

HESPERIIDAE-PYRGINAE

Epargyreus clarus huachuca (Dixon). **Grant Co.**: SP.

* *Erynnis lucilius afranius* (Lintner). **Grant Co.**: BM, CCC, LR, SP. **Sierra Co.**:

EP. July. This species, which had not been seen prior to 1976, was quite common. Perhaps it was overlooked or mistaken in the field for *E. persius fredericki* H. A. Freeman, which is also common in the region. This species was confirmed by genitalic examination.

E. meridanus meridanus Bell. **Grant Co.**: BM, LS, T.

E. pacuvius pacuvius (Lintner). **Grant Co.**: July.

E. tristis tatus (Edwards). **Grant Co.**: CCC, GR, MRV, SL, T. **Sierra Co.**: EP.

* *Pholisora alpheus* (Edwards). **Grant Co.**: MRV. One male on 3 July 1976.

P. catullus (Fabricius). **Grant Co.**: GR, MRV, SL.

Pyrgus communis complex. **Grant Co.**: FH, MRV.

Staphylos ceos (Edwards). **Grant Co.**: SL.

Thorybes pylades (Scudder). **Grant Co.**: GC, IC, MRV, SP.

HESPERIIDAE-HESPERIINAE

Amblyscirtes aenus ssp. **Sierra Co.**: EP.

A. cassus Edwards. **Grant Co.**: GC.

A. exoteria (Herrich-Schäffer). **Grant Co.**: CCC, SP. **Sierra Co.**: EP.

A. oslari (Skinner). **Grant Co.**: CCC. July.

A. simius Edwards. **Grant Co.**: T.

* *A. texanae* Bell. **Grant Co.**: MRV. One male on 3 July 1976.

Atalopedes campestris (Boisduval). **Grant Co.**: MRV. July.

Copaeodes aurantiaca (Hewitson). **Grant Co.**: MRV, SL.

Oarisma edwardsii (Barnes). **Grant Co.**: CCC, LGC. July.

Piruna polingii (Barnes). **Sierra Co.**: EP.

PAPILIONIDAE

- Papilio multicaudata* (Peale MS) Kirby. **Grant Co.:** GR.
P. polyxenes asterius Stoll. **Grant Co.:** FH. July.
P. rutulus arizonensis Edwards. **Sierra Co.:** EP. July.

PIERIDAE

- Colias (Zerene) cesonia* (Stoll). **Grant Co.:** Bayard. **Sierra Co.:** EP. July.
Eurema mexicana (Boisduval). **Grant Co.:** GR.
E. nicippe (Cramer). **Grant Co.:** GR, MRV.
Phoebis sennae eubule (Linnaeus). **Grant Co.:** T. **Sierra Co.:** EP. July.
Pieris protodice protodice (Boisduval & LeConte). **Grant Co.:** MRV.

RIODINIDAE

- Apodemia nais* (Edwards). **Grant Co.:** SP.

LYCAENIDAE

- Atlides halesus halesus* (Cramer). **Grant Co.:** SC, MRV. July.
Callophrys (Callophrys) apama apama (Edwards). **Grant Co.:** SP.
Callophrys (Mitoura) siva siva (Edwards). **Grant Co.:** MRV, SL. **Sierra Co.:** EP.
Erora quaderna sanfordi dos Passos. **Sierra Co.:** EP. July. A series was taken in mid-July 1976. The specimens were absolutely fresh so that it appears this species is bi-voltine. It is normally collected from February-May.
Hemiargus isola alce (Edwards). **Grant Co.:** GR, IC, MRV.
Leptotes marina (Reakirt). **Grant Co.:** GR, MRV.
Phaeostrymon alcestis oslari (Dyar). **Grant Co.:** GR, MRV.
Strymon melinus franki Field. **Grant Co.:** LS, MRV, SP. **Sierra Co.:** EP.

LIBYTHEIDAE

- Libytheana bachmanii* ssp. **Grant Co.:** MRV. July.

NYMPHALIDAE

- Asterocampa celtis montis* (Edwards). **Grant Co.:** MRV. July.
Chlosyne lacinia crocale (Edwards). **Grant Co.:** MRV, SL. July.
Danaus gilippus strigosus (Bates). **Grant Co.:** MRV.
Euptoieta claudia (Cramer). **Grant Co.:** GR, MRV.
Limenitis weidemeyerii angustifascia Perkins & Perkins. **Grant Co.:** SP.
Phyciodes campestris camillus Edwards. **Grant Co.:** MRV, SL. July.
P. mylitta arizonensis Bauer. **Grant Co.:** IC.
Phyciodes tharos (Drury). **Grant Co.:** MRV. July.
Poladryas minuta arachne (Edwards). **Sierra Co.:** EP.
Precis lavinia coenia (Hübner). **Grant Co.:** MRV, SL.
Thessalia theona thekla (Edwards). **Grant Co.:** MRV, SL. **Sierra Co.:** EP. July.

SATYRIDAE

- Cyllopsis pertipeda dorothea* (Nabokov). **Grant Co.:** IC.
Megisto rubricata cheneyorum (R. L. Chernock). **Grant Co.:** MRV.

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A RECORD OF *ANAEA AIDEA* (NYMPHALIDAE) FROM
SOUTHERN ILLINOIS

Two worn females of *Anaea aidea* Guerin-Meneville (Nymphalidae) were taken on the morning of 3 September 1972 at Brookport, Massac Co., Illinois. They were captured while on the wing in a weedy, abandoned railroad yard east of town during approximately two hours of collecting by the author. Both specimens were of the summer form, i.e., their forewings had a blunt apex. No others were seen in the area, nor have I observed them there since. This appears to be the first record of the species in Illinois, as previously, the furthest east it had been reported was in Scott Co., Kansas and Jeff Davis Co., Texas by Field (1938, Bull. Univ. Kansas, Lawrence, Kansas, biol. ser. 39: 108). This is mainly a tropical and subtropical insect that occasionally strays north, which undoubtedly accounts for this record. The specimens are currently retained in the author's collection.

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BUTTERFLIES AS PREY FOR CRAB SPIDERS (THOMISIDAE)

Although crab spiders (Thomisidae) have long been known to capture various insect prey while concealed in flowers, there are surprisingly few published observations where butterflies are the prey. Hobby (1930), Proc. Ent. Soc. London, 5: 107-110) cited a 1902 record by E. B. Poulton when a Satyrid butterfly, *Melanargia lachesis* Hübner, was captured by a crab spider in Spain. In another early record, Bell (1921, Bull. Brooklyn Ent. Soc. 16: 96-97) mentioned that *Epargyreus tityrus* Fabricius was captured by a crab spider, *Misumena vatia* (Clerck). Some years later, Voss (1953, Lepid. News. 7: 54) recorded that *Ancyloxpha numitor* (Fabricius) was similarly taken in Michigan, and *Libythea bachmanii* Kirtland and *Polites mystic* (Scudder) in Pennsylvania. None of the crab spiders were identified. Conway (1954, Lepid. News. 8: 28) reported the seizure of a *Papilio glaucus* Linnaeus by a crab spider in Illinois. Nielson (1958, Lepid. News. 12: 202) stated that a *Lycaena phlaeas americana* (Harris) escaped after being grasped temporarily by a crab spider in Michigan. In a more recent account, Jennings & Toliver (1976, J. Lepid. Soc. 30: 236-237) discussed capture of the pine butterfly, *Neophasia menapia* (Felder & Felder) in South Dakota by an immature crab spider, *Misumenops* sp.

It is of interest to record additional observations of butterflies which were attacked and captured by crab spiders. The senior author has been interested in this behavior, and since 1960 has made numerous observations in which crab spiders captured butterflies on various flowers in Maryland. In each case the prey and predator were collected and preserved, and the associated plant identified. The spiders were identified by the junior author.

In Table 1 are given the butterflies captured by two species of crab spiders, *Misumenoides formosipes* (Walckenaer) or *Misumenops celer* (Hentz), along with collection information. The data indicate that the former species was found with the butterfly prey more often than the latter. Most of the butterflies preyed on were Hesperidae, although much larger Papilionidae were also taken. Single species of Lycaenidae and Nymphalidae were captured. A total of 11 different species of butterflies were prey for these crab spiders; and 9 additional species of butterflies are recorded in this note. The captured butterflies varied from badly worn to nearly fresh condition. The senior author witnessed the actual attack on a male *Wallen-*

TABLE 1. Butterflies captured by crab spiders in Maryland.

Species	Sex	Date	Town (County)	Flower Host
Captured by <i>Misumenoides formosipes</i> (Walckenaer)				
HESPERIIDAE				
<i>Atalopedes campestris</i> (Boisduval)	M	6 Sept. 72	Fair Haven (Anne Arundel)	<i>Eupatorium purpureum</i> L.
<i>Atalopedes campestris</i> (Boisduval)	F	10 Sept. 74	Plum Point (Calvert)	<i>Trifolium pratense</i> L.
<i>Atalopedes campestris</i> (Boisduval)	F	16 Sept. 74	Plum Point (Calvert)	<i>Trifolium pratense</i> L.
<i>Atalopedes campestris</i> (Boisduval)	F	13 Sept. 75	Fair Haven (Anne Arundel)	<i>Eupatorium coelestinum</i> L.
<i>Atalopedes campestris</i> (Boisduval)	M	14 Sept. 75	Plum Point (Calvert)	<i>Tagetes</i> sp.
<i>Atalopedes campestris</i> (Boisduval)	M	1 Sept. 76	Fair Haven (Anne Arundel)	<i>Eupatorium purpureum</i> L.
<i>Wallengrenia otho</i> (Smith)	M	21 Aug. 74	Point Lookout (St. Marys)	<i>Eupatorium hyssopifolium</i> L.
<i>Wallengrenia otho</i> (Smith)	M	22 Aug. 76	St. Inigoes (St. Marys)	<i>Solidago graminifolia</i> (L.)
<i>Polites thorax</i> (Cramer)	M	19 Aug. 69	Beltsville (Prince Georges)	<i>Prunella vulgaris</i> L.
<i>Polites themistocles</i> (Latreille)	M	7 Sept. 76	Benedict (Charles)	<i>Cirsium arvense</i> (L.)
<i>Ancyloxypha numitor</i> (Fabricius)	M	20 Aug. 73	Plum Point (Calvert)	<i>Polygonum pensylvanicum</i> L.
<i>Lerema accius</i> (Smith)	M	5 Sept. 75	Breezy Point (Calvert)	<i>Buddleia</i> sp.
<i>Epargyreus clarus clarus</i> (Cramer)	-	31 Aug. 63	Bryantown (Charles)	<i>Eupatorium purpureum</i> L.
<i>Epargyreus clarus clarus</i> (Cramer)	F	11 Sept. 66	Breezy Point (Calvert)	<i>Clitoria mariana</i> L.
<i>Epargyreus clarus clarus</i> (Cramer)	F	10 Aug. 75	Plum Point (Calvert)	<i>Solidago graminifolia</i> (L.)
<i>Epargyreus clarus clarus</i> (Cramer)	F	30 Aug. 75	Plum Point (Calvert)	<i>Eupatorium hyssopifolium</i> L.
<i>Epargyreus clarus clarus</i> (Cramer)	M	4 Sept. 76	Patuxent City (Charles)	<i>Cirsium arvense</i> (L.)
<i>Epargyreus clarus clarus</i> (Cramer)	M	6 Sept. 76	Burnt Store (Charles)	<i>Eupatorium coelestinum</i> L.
<i>Epargyreus clarus clarus</i> (Cramer)	F	6 Sept. 76	Patuxent City (Charles)	<i>Cirsium arvense</i> (L.)
PAPILIONIDAE				
<i>Papilio glaucus glaucus</i> Linnaeus	M	4 Sept. 76	Patuxent City (Charles)	<i>Cirsium arvense</i> (L.)
<i>Papilio glaucus glaucus</i> Linnaeus	F	24 Sept. 76	Patuxent City (Charles)	<i>Cirsium arvense</i> (L.)
LYCAENIDAE				
<i>Strymon melinus humuli</i> (Harris)	F	8 Sept. 76	Benedict (Charles)	<i>Lespedeza virginica</i> (L.)
NYMPHALIDAE				
<i>Phyciodes tharos tharos</i> (Drury)	F	19 Sept. 73	Huntingtown (Calvert)	<i>Daucus carota</i> L.
Captured by <i>Misumenops celer</i> (Hentz)				
HESPERIIDAE				
<i>Poanes viator zizaniae</i> Shapiro	F	25 Aug. 60	Breezy Point (Calvert)	<i>Clitoria mariana</i> L.
NYMPHALIDAE				
<i>Phyciodes tharos tharos</i> (Drury)	F	31 Aug. 76	Plum Point (Calvert)	<i>Apocynum cannabinum</i> L.

grenia otho (Smith) on 21 August 74 which happened in an instant. The *Wallengrenia otho* dated 22, August 76 was collected by Jonathan P. Haliscak.

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OVIPOSITION BEHAVIOR OF COLONIZED *CALLOSAMIA PROMETHEA* (SATURNIIDAE)

In maintaining colonies of *Callosamia promethea* (Drury) we use paper bags to collect eggs from fertile females. Just prior to the hatching of eggs, we insert food plant cuttings into the bags and leave them there until the newly-hatched larvae have migrated and started to feed (Miller & Cooper, 1977, J. Lepid. Soc. 31: 146-147). This procedure involves only minimal handling of eggs and larvae and can be used with maximum effectiveness when a large number of eggs is deposited in a single bag over a short period of time. This minimizes the time food plants must be kept in the bags and provides groups of larvae of the same approximate age. To determine the optimum period for collecting eggs, we conducted a detailed study of the oviposition behavior of *C. promethea* females from our colony. This paper reports the oviposition profile we have elucidated for this species.

The adult moths used in the study were second generation individuals from a colony maintained in Frederick Co., Maryland. Pupae of both sexes were held in 4 large indoor emergence cages. As the adults emerged, the females either mated in the emergence cages, or were transferred to portable outdoor cages (Miller & Cooper, 1976, J. Lepid. Soc., 30: 95-104) to attract males. Only females that mated on the day of emergence or the following day were used. The mated moths were observed closely so that the females could be transferred to oviposition bags as soon as the pairs separated. Each female moth was held in a bag overnight and transferred to a new bag each morning until death. After a period of time sufficient to allow all eggs to hatch, each bag was opened to record the total number of eggs and the total number of larvae hatched.

TABLE 1. Summary of oviposition data obtained from colonized *Callosamia promethea* females.

Night After Mating	Number Females	Eggs Deposited		% Hatch
		Number	Cumulative %	
1	28	1695	35.5	94.1
2	28	1577	68.5	94.4
3	28	689	83.0	88.8
4	28	373	90.8	75.0
5	28	212	95.2	83.9
6	23	153	98.4	77.7
7	16	60	99.7	71.8
8	7	7	99.8	30.0
9	4	5	100	0
10	1	0	100	0

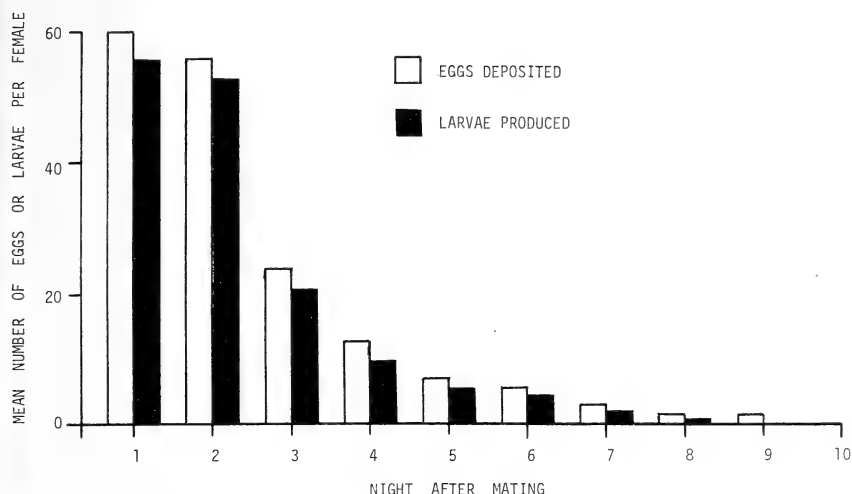


Fig. 1. Oviposition profile for colonized *Callosamia promethea* females.

Table 1 summarizes the data we obtained for 28 *C. promethea* females. These individuals deposited a total of 4,771 eggs over a 10-day period. All females survived for at least 5 days after mating; one individual lived for 10 days. The average longevity after mating was 6.8 days. The maximum number of eggs deposited by a single female that lived for 6 days was 262; the minimum was 80 eggs for a female that lived for 5 days. The average number of eggs deposited per female was 170.4. Data on percent hatch were variable, but the general trend was one of decreasing hatchability with increasing time after mating of the female. Percent hatch did not decrease markedly until after the 7th night.

To determine an optimum period for collecting eggs, we considered our findings in terms of the average number of eggs (or larvae) produced by a female moth (Fig. 1). Collecting eggs beyond the 3rd night after mating would be of decreasing efficiency for the effort involved because, although the percent hatch remains relatively high through the 7th night, the actual number of eggs deposited beyond the 3rd night is small. We have concluded from this study that the optimum period for collecting eggs under the conditions of our colony is during the first 3 nights after mating.

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BOOK REVIEWS

LIBRO ROJO DE LOS LEPIDOPTEROS IBERICOS, by M. G. de Viedma and M. R. Gomez Bustillo. 1976. Instituto Nacional Para la Conservacion de la Naturaleza, Madrid, Spain, 120 p., 82 figures (color photographs), 50 maps. Paper. Price \$5.50 (U.S.). Available from SHILAP, Apartado no. 331, Madrid, Spain.

This small paperback represents an entomological "first." Patterned after the International Union for the Conservation of Nature's (I.U.C.N.) Red Data Books on World endangered species, the authors present status summaries for 50 species of Iberian Lepidoptera. Each species is treated as Endangered (5 species), Vulnerable (4 species), Rare (20 species), Endemic (16 species), or Migratory (5 species). Butterflies receive most coverage, but 13 families are covered as follows: HesperIIDae (5 species), Lycaenidae (14 species), Satyridae (9 species), Nymphalidae (1 species), Papilionidae (3 species), Epipyropidae (1 species), Zygaenidae (4 species), Saturniidae (3 species), Endromididae (1 species), and Sphingidae (2 species). With the exception of a summary page in English, the book is entirely in Spanish, as one would expect.

The treatment for each species includes sections on distribution and flight period, habitat and life cycle, status and population, and recommendations.

The intent of the book is to be a preliminary assessment of Iberian Lepidoptera in need of some conservation effort or in need of continuing scrutiny.

Apparently, the status of Iberian Lepidoptera lags behind that of the remainder of Western Europe, since only five somewhat unsuitable species are cited as Endangered: *Coenonympha oedippus* (Satyridae) is thought to be extirpated in Iberia, but is widespread in other portions of Europe; *Samia cynthia* and *Antheraea pernyi* (both Saturniidae) are both Asiatic species brought to Europe by man in the 1800's for their possible silk-producing qualities. *Epipyrops schawerdae* (Epipyropidae) may be endemic, but is known only from a single individual, and represents an esoteric family not regularly sampled by collectors; *Procris predotae* (Zygaenidae), a Spanish endemic, is the most logical candidate of the five, but still remains little investigated.

Documentation or even mention of threats to the habitats of the fifty species is largely lacking in the book. Under provisions of the United States' Endangered Species Act of 1973 most of these species could not be listed because of the lack of appropriate documentation of threats to their habitat.

It is heartwarming to see that the Spanish have begun to assess the status of their endemic Lepidoptera with an eye fixed toward future conservation efforts. Let us hope that the future efforts include further field study of potential candidates, and more importantly, acquisition, protection and/or management of the habitats upon which the more unique taxa depend.

I recommend this book to all members with conservation interests and an aptitude for reading Spanish.

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THE CLASSIFICATION OF EUROPEAN BUTTERFLIES, by L. G. Higgins. 1975. 320 p., 402 line drawings. Wm. Collins and Sons, Ltd., Glasgow. Price: £7.50 net.

Within the pages of this book are the justifications for a radically different classification of the European butterflies, one that was long overdue. The data that are included in the present book were originally to have been incorporated into the

Higgins and Riley *Field Guide to the Butterflies of Britain and Europe*, but were not. In some respects it is unfortunate that this information was not placed in the *Field Guide*; the amateur would have been exposed to it and had the opportunity to make use of it or not as he saw fit. The present volume is more likely to have a limited audience and will most likely be purchased by the professional lepidopterist and the advanced amateur only. The idea of placing a great deal of technical detail in basically an identification book is not new—Godman and Salvin interwove beautifully colored plates with illustrations of structural details very successfully in the Rhopalocera section of the *Biologia Centrali-Americana*, a work that has remained a standard reference for the last three-quarters of a century. The combination of these details in the *Field Guide* do the same thing for the European species, and the serious student cannot afford to be without it.

The illustrations, none of which is colored, are highly informative, but not overdone. The reader searching for pretty pictures will be disappointed, unless he is impressed by pictures of structural details. These details are clearly illustrated and provide much of the basis for the "new systematics" of the European butterflies. With the illustrations at hand it would be difficult for a worker to seriously question the conclusions reached.

The errors are few and far between. Most of the literature citations given are correct (I know I learned a great deal about who first proposed what higher category), and the consistency with which the oldest name is used for family-groups is laudable. The only exceptions to this are the use of Riodinidae instead of the older Nemeobiidae (there is an appeal pending before the International Commission on Zoological Nomenclature for the validation of Riodinidae) and the Pierinae is credited to Swainson in 1840 while the Pieridae is attributed to Duponchel, 1832. The "Code" is specific in its assertion that when one family-group name is proposed, all other family-group names on the same stem are proposed by implication. I suspect that the Pieridae-Pierinae situation was merely an oversight. Other errors of omission or commission largely may be ascribed to Dr. Higgins not being familiar with some of the work done on this side of the Atlantic, but American authors have been far less cognizant of what has been done in Europe, so Higgins' omissions may be forgiven in this regard.

On balance, this book is a magnificent piece of workmanship and of scholarship, perhaps the best that has been done on Palearctic butterflies in recent years. No rhopalocerist who is more than a hobbyist can afford to be without it. Now the gauntlet has been flung—we Americans need to do a similar work on the Nearctic butterfly fauna!

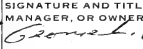
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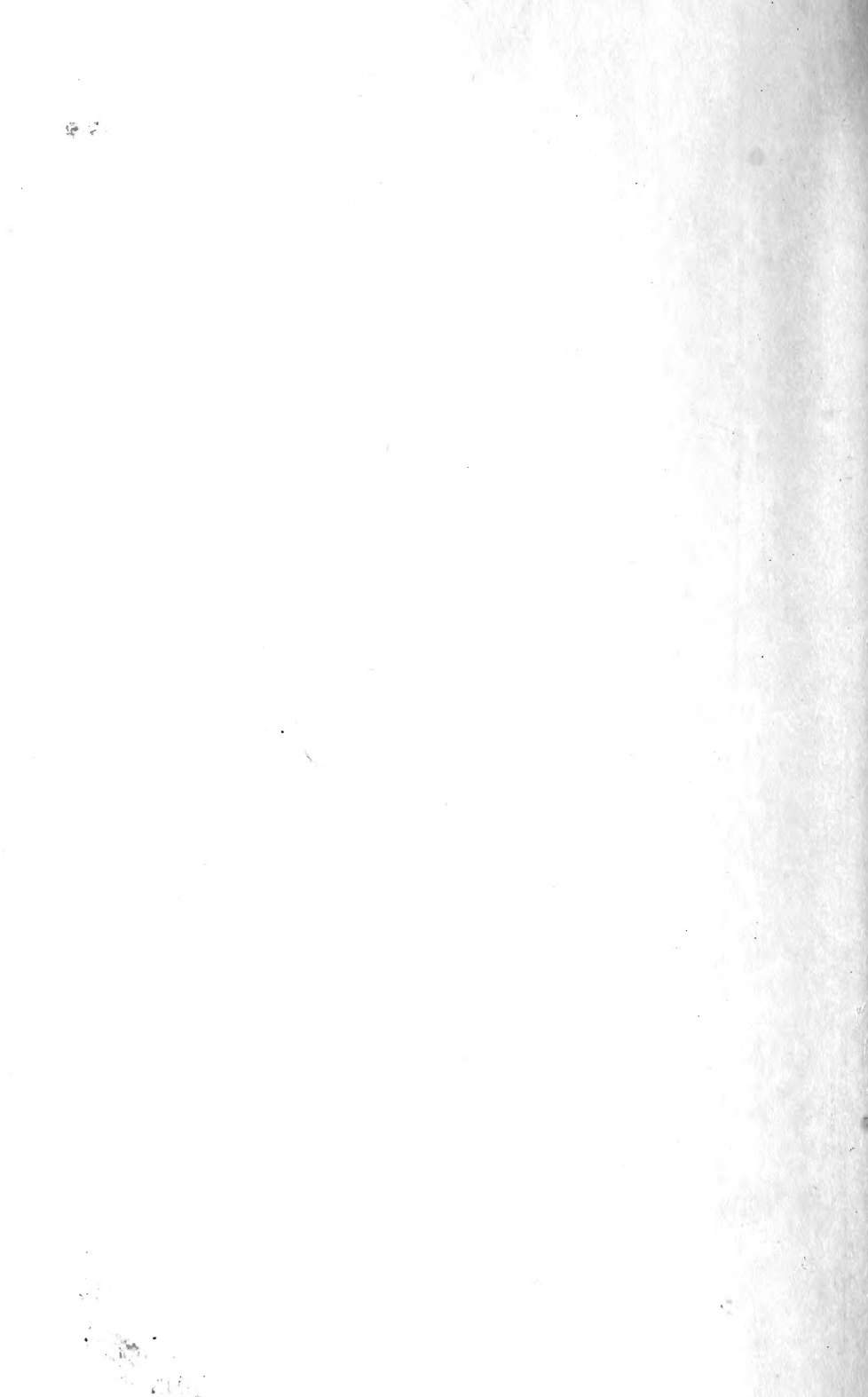
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